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Effective teaching: Sensory learning styles versus general memory processes[1]

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Abstract

Tailoring teaching strategies to accommodate students' sensory learning styles (e.g., visual, auditory, kinesthetic) is widely recommended across all levels of education from kindergarten to university. However, research stretching across five decades suggests that such tailoring does not enhance students' learning. In contrast, research does indicate strong learning benefits for methods such as integrative elaboration, distribution during learning, and frequent recall of learned material. This paper reviews evidence of learning associated with teaching focused on both sensory learning styles and general memory processes to encourage educators to adopt more evidence-based methods to enhance effective instruction.

Teaching is a career with many challenges. Teachers must have knowledge and skills at a sufficient level to help others develop those skills and knowledge, and they also need expertise in communication methods, human development, and group dynamics. Increasingly, teachers must practice their trade under conditions of economic scarcity, requiring great efficiency. Fortunately, one thing teachers do *not* need to do is to tailor their methods to their students' individual sensory learning styles.

This is not because such learning styles do not exist. There is ample evidence that we all differ in our capacities, preferences, and habits of accessing and managing new information (e.g., Kozhenvnikov, Evans, & Kosslyn, 2014). However, with respect to our learning performance, these differences between us are greatly overshadowed by the similarities of our memory systems. The overarching purpose of having a memory is to improve future decisions on the basis of past experiences (e.g. Sherry & Schacter, 1987). Evolutionarily, the predominance of our memory similarity makes a great deal of sense. Humans have been described as occupying a "cognitive niche" (e.g., Pinker, 1997), using our memory and intelligence to compensate for our lack of unique physical abilities to successfully compete for our place in the world. The success of this strategy is obvious – humans have colonized most ecosystems on the planet, using our ability to learn from each other and adapt our knowledge and skills to current challenges of all kinds. Individuals whose learning is so fragile as to operate well only in certain optimal circumstances would not likely survive to pass their constrained abilities on to their offspring.

The primary goal of this paper is to alert educators to the robust evidence that tailoring instruction to students' sensory learning styles is an ineffective way to increase student learning,[2] and to direct educators' attention to some alternative effective techniques based on general memory processes. To this end we describe a sample of the research on both sensory learning styles and memory-based techniques. We will not provide thorough reviews of either literature, but will instead give a flavor of relevant

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[2]There are, of course, other ineffective learning/teaching strategies that are popular. However, we have chosen to focus solely on learning styles because of their ubiquity throughout all levels of education despite the extensive research that the style-matching strategy is ineffective. We hope that this clear example of how using evidence could improve teaching practice will then generalize to other strategies (both effective and ineffective).

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studies and direct interested readers to existing reviews and meta-analyses.

There have been many critiques noting the absence of evidence that tailoring teaching to students' learning styles benefits learning performance. These critiques have apparently had little effect on the beliefs and behavior of teachers and teacher educators. One of the reasons for this lack of effect may be that alternative pedagogic strategies were not suggested to replace the focus on individualized learning styles (Alferink, 2007). So, rather than repeat the strategy of simply reviewing this evidence, we will contrast the negative evidence for sensory learning styles with the strong evidence in support of learning strategies based on general memory processes, describing in some detail a few relevant studies from each literature. It is our hope that this contrast strategy will encourage teachers and teacher educators to adopt an evidence-based approach to effective instruction in a way that previous reviews have not.

Sensory Learning Styles

The theory of learning styles is ubiquitous throughout educational systems, from kindergarten to post-graduate studies. For example, we have noticed sensory learning styles mentioned in both an orientation brochure for kindergarten classes and in workshops for university teaching assistants. The central claim of learning styles theory is that we differ from each other in learning abilities and preferences, and that matching these preferences with instructional methods and learning environments will greatly improve students' learning. There is no doubt that there are individual differences in both cognitive abilities and information-presentation preferences (e.g., Kozhenvnikov, *et al*., 2014). The important applied question, however, is whether it is useful to assess and develop curriculum and study strategies specific to those differences. The learning styles hypothesis is that such effort improves learning, yet the empirical evidence, gained in both applied and experimental settings, provides no evidence of such benefit.

Although there are a great number of learning styles models outlining individual differences purported to influence learning performance (e.g., Coffield, Mosely, Hall & Ecclestone, 2004), in practice the most ubiquitous model focuses on sensory modalities (visual, auditory, kinesthetic; Scott, 2010). These sensory differences are the most frequently mentioned in professional contexts and the most often researched aspects of learning style. As our primary purpose is to present the argument that the development of classroom methods based on general memory processes would serve the goal of improved student learning better than attention to students' learning styles, we primarily limit our focus to this most extensively used type of learning style.

Most effort (time and money) in schools and other applied settings (e.g., Sanderson, 2011) is expended to assess students' learning styles. In practice, however, many fewer education departments or teachers develop extensive curricula or instructional methods to match these styles, perhaps because individuating instruction to this extent would entail massive expense and effort (Stahl, 1999). The good news from a review of the research is that such expense is unnecessary, and that relatively less expensive and effortful (albeit perhaps less narratively attractive) strategies can make large differences in student capability.

There is a large literature on learning styles in scholarly and professional journals, but most of these articles promote the application of learning styles theory to student assessment and instructional design rather than assess the truth of its claims. Proper assessment of whether learning is improved by matching instructional materials and methods with learners' styles requires a factorial experimental design (Pashler, McDaniel, Rohrer, & Bjork, 2008; Lalley & Gentile, 2009). One factor would be participants' learning styles (at least two levels, such as visual and auditory), and the other factor would be instructional material (e.g., visual and auditory). If the claim that matching instruction with learner preferences is true, a significant interaction would be observed, with visual learners performing better with visual instruction and auditory learners performing better with auditory instruction. Several well-executed studies using this design have been conducted over the past five decades, and in no case has a significant matching effect been observed.

For instance, Vandever and Neville (1974) assessed the perceptual aptitudes of all second grade students in a large school, then assigned students to visual, auditory, or kinesthetic reading instruction groups. Students with both strength and weakness for each modality were included in each instructional group. The results indicated no differences between groups in the number of words learned and there were no differences between students taught to their strength vs those taught to their weakness. Similarly, in a longitudinal study, first grade students assessed as either visual or auditory learners were assigned to classrooms using either an auditory or a visual approach to teaching reading (Bateman, 1967). After 9 mo. of instruction, students' reading achievement scores indicated that the auditory approach was better than the visual approach for all students, regardless of their assessed modality strength.

Using a slightly different approach, Kreamer (2013) had elementary school students study eight short stories over 2 wk., each presented in a different sensory modality, and then tested students' recall of the central features of the stories. The stories were presented visually (newspaper clippings, maps), orally (audio recording), or kinesthetically (place story phrases on text board), with each student learning stories in each modality. She observed that students' best performance was observed with the same modality for only 25% of participants (i.e., chance level), and that the correlations between students' self-reported learning style and their performance were not significant.

Research using this design has also been conducted to examine non-sensory learning preferences. For example, Winne (1977) examined the match between grade six students' preferences and teachers' structure and questioning methods and observed no effect of matching. Rather, student aptitude (interest and prior knowledge) for the subject area had the strongest effect on learning performance regardless of teaching method, an individual difference we will return to.

Another strategy used to test whether matching instruction or to-be-learned material with students' sensory learning styles influences memory performance has been to examine correlations between style matches and performance. Krätzig and Arbuthnott (2006) gave university students standardized memory tests featuring visual, verbal, or kinesthetic memory, and observed no significant correlations between the test modality and assessed learning styles. Although these standardized tests were not "instruction," the material was presented and assessed entirely in each of the sensory modalities, and is thus a good analogue of modality-specific instruction. Similarly, in a within-school field study, Wilson (2011) examined several aspects of learning style, including sensory modality. No significant correlation was observed between preference/instruction match and students' performance in four subjects, language, mathematics, science, and social studies.

Throughout the past five decades, educators and researchers have published numerous reviews and meta-analyses of this research, examining learning styles generally (e.g., Bracht, 1970; Winne, 1977; Lloyd, 1984; Curry, 1990; Reynolds, 1997; Dembo, & Howard, 2007; Ivie, 2009; Lalley & Gentile, 2009; Scott, 2010) and sensory learning styles specifically (e.g., Tarver & Dawson, 1978; Kampwirth, & Bates, 1980; Kavale & Forness, 1987; Stahl, 1999; Willingham, 2005; Pashler, Bain, Bottge, Graesser, Koedinger, McDaniel, *et al*., 2007). All concluded that there was no empirical support for the practice of tailoring instruction to students' learning styles.

Persistence of Learning Styles Myth

Given the resounding lack of empirical evidence supporting instruction tailored to students' sensory learning styles, why has this idea shown such success and persistence? Several authors have posited plausible reasons.

First, educators are often unaware of the lack of evidence supporting the claims of learning styles theory (Scott, 2010), despite the availability of such evidence. The general claims about individual differences are true, and we all have experiential evidence of such differences. However, these observations lead to the "fundamental attribution error" (Ross, Amabile, & Steinmetz, 1977) – believing that actions and effects are due to individual characteristics, rather than contextual (or in this case, general) factors. Alferink (2007) and Willingham (2005) further suggest that confirmation bias, the human tendency to notice information consistent with our beliefs and ignore or discount disconfirming evidence (Nickerson, 1998), is largely to blame. Such beliefs are initially instilled through formal (e.g., education classes) and informal (e.g., in-service workshops) cultural events. Furthermore, Alferink (2007) argues, there is a lack of consistent information about truly effective instructional strategies, which leaves teachers vulnerable to such superstitious behavior given the difficulty of their tasks. The purpose of the second section of this paper is to correct the lack of alternative options.

The success of learning styles theory is also historically consistent with the rise of humanistic views of education involving respect for individuals and learner-centered (as opposed to content-centered or teacher-centered) education. The idea that instruction should be targeted to learning styles is consistent with these widespread educational values, and thus receives moral and cultural support within educational communities. Teaching to different sensory learning styles is viewed by departments of education as a component of responding to diversity (Willingham, 2005; Scott, 2010).

Given the impression of valuing and accommodating the diversity of individual students that learning styles theory provides, what is the harm in assessing sensory learning styles, despite this lack of evidence? As Scott (2010) puts it, this is "…not a harmless idea. The harm it perpetrates has its origins in, first, that attempting to adapt pedagogy to learning styles distracts practitioners from those aspects of teaching practice that have proven benefits to children's learning and, second, that it encourages a cultural tendency to look for explanations for behavior and attainment in the wrong place" (p. 11). "Rather than being a harmless fad, learning styles theory perpetuates the very stereotyping and harmful teaching practices it is said to combat." (Scott, 2010, p. 5). In short, the continued endorsement of learning styles theory interferes with the development of evidence-based practice in education and the wider community.

General-Purpose Memory Processes

We argue that generic human learning mechanisms are more powerful than the variability introduced by individual differences in ability or preference. The purpose of a memory system is to enable individuals to use their past experience to make better decisions in the present (Sherry & Schacter, 1987). To accomplish this, learning works best when (1) new knowledge and skill are integrated with previous knowledge and (2) new information proves to be useful in solving current problems and is thus frequently recalled. These two features underlie two of the instruction and study methods often observed to improve students' learning performance – integrative elaboration (known as elaborative encoding in the cognitive literature) and retrieval practice. A third method, distributed learning and practice, is also partly explained by frequent and varied retrieval of new information. We outline each of these methods and describe a sample of the evidence that these strategies improve learning. These three methods are not, of course, the only general memory-based learning strategies (e.g., Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). However, we chose these strategies to highlight because (1) they are well researched in applied settings, and (2) they are relatively straightforward to integrate into classroom settings.

One issue that should be addressed before describing effective learning strategies is what we mean by "effective learning." One metric might be speed of acquiring new information, but a better measure is likely the durability and flexibility of the new information and skills. Durable learning creates knowledge that can be recalled over long periods of time, not just immediately after study. Flexible learning means having memories that can be recalled in a variety of situations and for a variety of purposes, not only in the context of the original learning situation. Factors that influence speed of initial learning can often create memories that are transitory and inflexible, so maximizing the speed of initial learning may actually impair efficient learning in the long term (Bjork & Bjork, 2011). Thus, the following methods may slow the speed of acquiring new knowledge to some degree, creating what Bjork and Bjork (2011) call "desirable difficulties."

One general message that can be taken from this section of the paper is that there is no 'magic bullet' that will enable students to learn without effort, no matter how much work teachers put into presentation. To acquire new memories and skills learners must "put their minds to it" and educational practices can provide scaffolding and environmental support to enable students to do this more successfully (e.g., Heath, 2014).

Integrative Elaboration

When new information fits with what one already knows and understands, it enriches one's competence, rather than existing as an isolated area of knowledge that is seldom used. This is why study techniques for high school and postsecondary students such as asking oneself questions while reading new chapters in textbooks (e.g., asking why a given fact would be true; Roediger & Pyc, 2012), or asking how this relates to other things one knows (Thomas & Robinson, 1972) are effective. Diagramming techniques such as concept maps also serve a similar purpose.

The benefits of integrative elaboration have been observed across all levels of education. For example, Bransford, Stein, Shelton, and Owings (1981) studied how Grade 5 students approached learning unfamiliar material by having them read paragraphs aloud, study them, and then answer questions about the paragraphs. They interviewed students about how they studied the material and observed that students who recalled more of the material used active study strategies such as comparing the new material with their previous knowledge. Less successful students, in contrast, reported more passive study strategies such as rereading the paragraph. Stein, Bransford, Franks, Owings, Vye, and McGraw (1982) further observed that the more successful students generated precise elaborations that increased their understanding of to-be-learned sentences, whereas less successful students' elaborations did not increase sentence meaningfulness. For example, when asked to learn "*The hungry man got into his car*," a successful student added "*to go to the restaurant*," and a less successful student added "*and drove away*." Precise elaborations were generated for 70% of the sentences by successful students, 46% of sentences by average students, and 31% of sentences for poor students. More precise elaborations were associated with greater recall of the base sentences (e.g., 91% vs. 76% for imprecise elaborations). Training poorer students to create more precise elaborations increases their memory success (Stein, *et al*., 1982; Wong & Sawatsky, 1984), indicating the potential value of teachers adopting such strategies.

Smith, Holliday, and Austin (2010) had high school students read a new chapter in their biology text either interrupting their reading with questions about a new fact (e.g., why would this be so?) or reading the chapter through twice. On a final test of the chapter material, those in the self-questioning group scored an average of 76%, compared to 69% for the reading twice group. (The final test did not test material that had been questioned during reading for the self-questioning group, but only text information that had not been explicitly questioned.)

Similar findings are observed at the post-secondary level. Pressley, McDaniel, Turnure, Wood, and Ahmed (1987) had university students study sentences (e.g., "*The strong man carried a shovel*.") for later recall. In some conditions, the sentences were followed by questions directing learners to elaborate the meaning of the sentence (e.g., "*Why did that particular man do that?*"), and in others an elaboration was provided by the experimenters (e.g., "*to dig out heavy rocks*"). Participants were required to recall only the sentences, not the elaborating information. The results indicated that participants recalled 77% of the sentences followed by elaboration questions, compared to 46% of sentences for which the elaboration was provided. When students created their own elaborations of the sentences, they were much more likely to remember those sentences.

One implication of this feature is that having existing knowledge in one's memory that is relevant to new information is an obvious advantage to a learner (e.g., Winne, 1977). In formal educational settings such relevant knowledge is often specified as prerequisites or basic knowledge. For this reason, one individual difference factor that is well worth assessment by teachers is students' prior knowledge and competence in a subject area (e.g., McNamara, Kintsch, Butler-Songer, & Kintsch, 1996; Lalley & Gentile, 2009). If students do not have basic knowledge necessary to understand new information (e.g., counting before learning addition), then it will be very difficult for them to durably attain the new knowledge. This is why one instructional practice that demonstrably improves learning is tailoring instruction to differing levels of prior knowledge and experience (Dembo & Howard, 2007).

Integrative elaboration methods can be integrated into classrooms in many ways. Class discussions about how a new lesson relates to other things students know, beginning each new lesson with a review of previous material or skills, or creating games or exercises that require integrating old and new information to solve all provide integrative elaboration. Elementary school teachers often integrate this into their teaching automatically – pointing out how individual letters go together to form words, words go together to form sentences, sentences go together to form stories. Those of us who teach in postsecondary education are sometimes less careful of this, forgetting the steps we ourselves took to acquire complex knowledge and thus "throwing our students into the deep end" without the necessary scaffolding of prior knowledge and skill.

Retrieval Practice

Facts and information do not exist in isolation in our memories, but are organized into associative webs of knowledge (Collins & Loftus, 1975), concepts (e.g., Keil, 1992), and mental models (e.g., Mills & Keil, 2004). This is why once young children learn about one type of bird (e.g., robins) they easily make predictions when they see another bird (e.g., goldfinch), such as that it can fly, raises its young in a nest, eat bugs or seeds, etc. Furthermore, information that has been more frequently recalled from such memory webs is more likely to be useful in making future decisions and is thus more likely to become durable knowledge than is information that is seldom consulted. For instance, Bahrick (1991) observed more than 50-yr. retention of unpracticed high school algebra and geometry knowledge for individuals who had gone on to take college-level mathematics courses (which required use of the high school skills). Individuals who achieved the same grades in their high school courses, but who took no subsequent mathematics courses, showed very little retention over the same time span. Essentially identical findings are observed for high school foreign language learning (Bahrick, 1984). Taking subsequent courses in a subject requires use of the foundational knowledge, apparently resulting in very durable learning of the earlier classroom material.

Thus, one way to ensure stronger learning of particular knowledge or skills is to bring that information to mind more frequently. Such retrieval occurs naturally when a learned fact or skill is useful to daily life, such as learning to speak or tie one's shoes. In school situations, tests also provide an opportunity to bring newly learned information to mind. The "testing effect" is a robust finding—information that has been frequently tested is more readily recalled than untested information (Carrier & Pashler, 1992; Roediger & Karpicke, 2006; Butler, 2010; Karpicke, 2012), even for preschool children (Fritz, Morris, Nolan, & Singleton, 2007).[3]

For example, Roediger and Karpicke (2006) had university students study textbooks and then tested them on their recall of the material 1 wk. later. One group of students studied the assigned text four times (S4), another studied the text three times and self-tested their recall once (S3R), and a third group studied the text once then self-tested their recall three times (SR3). Those who studied the text four times recalled a mean of 40% of the material, the S3R group recalled 55%, and the SR3 group recalled 60%. All groups spent the same amount of time with the text material, but even a single reading followed by repeated self-testing improved retention to a greater extent than multiple study periods. When students in the three groups were asked to predict how well they would recall the material, the pattern was exactly opposite the observed test results (i.e., SR3 participants predicted the lowest recall and S4 participants predicted the highest), indicating that students are unaware of the importance of retrieval to their memory performance. Providing effective feedback subsequent to formal or informal testing increases the benefit of retrieval practice even further (Hattie, 2009; McDaniel, Howard, & Einstein, 2009; Karpicke & Roediger, 2010; Agarwal, Bain, & Chamberlain, 2012), but learning improves even without external feedback, as shown in the SR3 group of Roediger and Karpicke's (2006) study.

Retrieval practice works for learning concepts as well as for learning facts. For example, Karpicke and Blunt (2011) compared university students' recall of science text material after rereading, elaborative encoding (concept maps), and retrieval practice. The test given 1 wk. later included both factual and inference questions based on the studied material. For both verbatim and inferential questions, students who received retrieval practice scored a mean of 70%, much better than con-

[3]It should be noted that some of these studies involved learning only simple material (e.g., pairs of words; Carrier & Pashler, 1992), and very short retention intervals (e.g., less than 1 hour; Fritz, *et al*., 2007). Even studies that involved more complex material (e.g., encyclopedia entries; Butler, 2010) had relatively short retention intervals (1-week). Recently, studies more applicable to classroom situations in both learning content and retention intervals have been conducted, as described later in the paper (e.g., Agarwal, Bain, & Chamberlain, 2012).

cept mapping study (55% for inferential and 45% for verbatim questions), and simply studying the text (less than 30% for both inferential and verbatim questions).

The benefit of retrieval practice has also been observed with younger students. An extensive test of whether retrieval practice influences learning in classroom settings was undertaken by a team of researchers and teachers (Agarwal, *et al*., 2012). For several years this group has studied the performance of Grade 6–8 students in social studies and science classes, investigating the long-term effects of these strategies on students' performance in semester-end (3–5 mo. recall) and year-end (8 mo. recall) tests. The results of this thorough research program provide unequivocal evidence of the value of retrieval practice for regular classroom learning. For example, using a study design in which the same Grade 6 students either reread or were tested on different content within a unit (equivalent time with each), students achieved 79% on the semester-end test for tested material compared to 67% for reread material (Roediger, Agarwal, McDaniel, & McDermott, 2011). This benefit was also observed for year-end tests, even when the type of questions (i.e., definition, concept, or application questions) or test format (i.e., multiple choice or short answer tests) of quizzes and final tests differed (McDaniel, Thomas, Agarwal, McDermott, & Roediger, 2013; McDermott, Agarwal, D'Antonio, Roediger, & McDaniel, 2014).

Distributed Learning

Another method that improves learning is distributed learning, which can also be partly attributed to retrieval practice (but see Litman & Davachi, 2008). In many situations, both simple and complex, learning a new skill or knowledge set is most efficiently achieved by separating instruction and practice sessions across time (for reviews, see Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012). For example, Baddeley and Longman (1978) had students learn touch typing. Different groups of students practiced 1 hr. per day, 2 hr. per day, 1 hr. twice per day, and 2 hr. twice per day. With 60 hr. of total practice, those who practiced 1 hr. each day performed best (average keystroke/minute = 80 compared to 65 for the group who practiced 2 hr. twice a day). In a classroom setting, Bloom and Shuell (1981) had high school students study French-English vocabulary pairs for 30 min., either in one session or in 10-min. sessions across three days. When tested immediately, the two groups performed similarly (80-85%), but on a test 1 wk. later, the one-session group scored 55%, compared to 75% for those who studied across three days. A similar effect was observed for more complex classroom material: Grade 7 and 8 students who received more frequent tests (practice) during a 1-mo. science unit achieved 82% on year-end tests 8 mo. later, compared to 69% for who were given only unit-end quizzes (McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011). Similarly, Rea and Modigliani (1985) observed benefits of distributed practice for Grade 3 students learning spelling and multiplication facts.

This effect of distributing learning over time (keeping the total amount of time constant) has been observed for physical skills (e.g., typing, pistol shooting; Baddeley & Longman, 1978; Krätzig, 2015), academic skills (e.g., language vocabulary, arithmetic skills, science concepts; Rea & Modigliani, 1985; Bahrick, Bahrick, Bahrick, & Bahrick, 1993; Fritz, Morris, Acton, Voelkel, & Etkind, 2007; Sobel, Cepeda, & Kapler, 2011; Vlach & Sandhofer, 2012), and complex social skills (e.g., coaching skills, eye-witness interviewing; Grant, 2007; Heidt, 2013).

Even implicit learning, attaining information without conscious effort, is improved by distribution. Kornell and Bjork (2007) asked students to learn to identify the styles of 12 artists by studying six pictures by each artist. The six pictures by each artist were presented either consecutively (in a block) or interleaved with the other artists. Participants were then asked to view new pictures and identify which artist had painted each. Over 60% of participants predicted that they would do better on this task when artists' pictures were presented in a block, but performance indicated that almost 80% of participants in the interleaved study condition correctly identified the artists of the new pictures compared to less than 20% in the blocked condition.

Based on the results of a series of carefully controlled studies with university students, Rawson and Dunlosky (2011) recommend that durable learning can be most efficiently achieved with a combination of thorough initial learning (practicing until to-be-learned information is correctly recalled three times) and three distributed sessions of retrieval practice with feedback. In their studies, this combination achieved durable learning for tests up to 4 mo. after the last retrieval practice with reasonable efficiency (i.e., total study time).

Both distributed instruction and frequent retrieval practice can be integrated into classrooms at all levels. The typical daily classroom schedule provides instructional distribution (Pashler, *et al*., 2007; Dunlosky, *et al*., 2013), as does the practice of scheduling classes throughout the day for high school and post-secondary students (e.g., math at 9:00, history at 10:00, etc). Frequent testing, either formal or informal, can also readily be integrated into classroom settings (e.g., Agarwal, *et al*., 2012). Although neither students nor teachers enjoy tests, frequent testing demonstrably improves the durability of learned information, and thus is more beneficial than developing instructional materials in several sensory modalities. Retrieval practice can also be introduced (more enjoyably than testing) through classroom games and exercises requiring use of previously learned material. For example, one of our colleagues regularly conducted a "jeopardy-style" game in his class to provide retrieval practice, and another colleague had students write short position papers on text material prior to class discussion.

Conclusion

Ideas that encourage us to diagnose or categorize ourselves or each other are apparently very attractive to people, and thus many such ideas achieve popularity and mainstream status without much evidence of their value. Learning styles is one such notion. However, decades of research attempting to demonstrate the value of matching instruction to students' sensory learning styles has indicated no support for the value of such instructional tailoring. Thus, although interesting, identifying learning preferences does not further the goal of increasing student learning.

In contrast, tailoring instruction to processes that operate similarly for everyone can improve the competence and skill of all students. In the political context of humanistic education, such practices do not seem to highlight respect for each student as a unique individual. However, enabling every student to achieve their optimum in life by ensuring durable and flexible learning is, arguably, the ultimate in respect for their individual value. The goals of education, like those of other professions, are best served by evidence-based practice. As stated by Agarwal, *et al*. (2012), "If we truly want to reach all students, we need to educate current and future teachers about research-based strategies that lead to authentic learning." (p. 446). The evidence strongly indicates that strategies that support general learning processes such as integrative elaboration and retrieval practice have a much greater impact on student learning than strategies aimed at individual differences in sensory abilities and preferences.

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