International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 4, Issue 4, May, 2019

Extending the Boundaries of Multisensory Teaching: An Introduction to the Dual-Continuum Model of Sensorial Education

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Investigations into the prominence of using senses in education is not a new line of research. The pedagogical values of multisensory teaching have been pondered for years. However, in order to speed up the process of instruction and smooth the path for teaching abstract entities, the authors have extended the boundaries of multisensory teaching, proposing an inclusive model. The dual-continuum model of sensorial education, breaks sensory teaching down into thick-slice and thin-slice sensory education. While the former alludes to conventional multimodal approaches, the latter contrives to adopt a unimodal outlook and create learning outcomes resembling those generated by multimodal teaching practices. Imagery, as a thickening strategy to progress from thin to thick education, is put forward, concluding that, sensory, mental representations make up for the missing sensory input required to obtain in-depth understanding. Therefore, learning in light of thin education could come in two different forms namely imagery-driven thin education and imagery-deficient thin education. Moreover, in this model, we make a distinction between sense and modality to underscore the unique contributions of instructional and environmental features. To close the loop, the factors which have a part in better administration of the model are discussed in the context of education.

1. Introduction

Teachers' lifelong quest for the most suitable teaching approaches has given way to different techniques including the recruitment of many, if not all, of the human senses. To tailor to the academic needs and gifts of students, there is a commonly held belief that teachers are required to simulate natural learning environments (West, 1994) and make use of at least three learning modalities (i.e., auditory, visual, and tactile) in their regular teaching practices (Gadt-Johnson, 2000). Pioneered by Montessori's (1912) ground-breaking theory and philosophy of education, the movement of sensory training was led nearly 100 years ago in Italy, winning widespread support from prominent educators and public figures of her time. During the last decades, however, the movement has entered a new era by virtue of new brain research findings. The rapidly expanding field of cognitive neuroscience provides neurological support for the efficacy of diverse pedagogical approaches in general and multisensory teaching in particular. In neural terms, every kind of learning experience leads to the formation of numerous fiber connections and neural networks over the course of time. Information integrated across multiple sensory modalities enhance learning in such a way that more neural ensembles are developed from a set of different neural structures coming from the involvement of different modalities. These learning experiences, being multisensory in nature, are thereafter encoded through large networks of neurons (Goswami, 2008; Lacey & Lawson, 2013). Under such a regime and on account of the interaction between senses and the cortex in multisensory learning protocols, as opposed to unisensory training schemes, the brain performance, as for the neural firing rates and the response latencies, improves to a considerable extent, stimulating neuroplasticity (Shams & Seitz, 2008).

Despite the large body of research documenting the cognitive advantages of multisensory teaching (e.g., Shams & Seitz, 2008) and the undeniable excitement induced from the implementation of the five traditional senses, it is not always possible to depend largely upon different kinds of sensory input for optimal leaning. The feasibility of maintaining sensory perception decreases as the learners step into higher grades and embark on finding out abstract entities and dependencies (Katai & Toth, 2010). The situation might deteriorate even further as numerous environmental barriers such as time limitations, physical space, or lack of access to facilities pose tough challenges to teachers.

To remedy the shortcomings and put some flesh on conventional multisensory teaching philosophies, Pishghadam (2018) has come up with a new pedagogical model of sensorial education encompassing *thick-slice sensory education* (henceforth thick education) and *thin-slice sensory education* (henceforth thin education). We add extra details to the two views by differentiating between *senses* and *modalities*. While thick education is reminiscent of multisensory instruction, thin education, comprising *imagery-driven* and *imagery-deficient* dimensions, draws on the unique qualities of auditory input, as the dominant modality of classroom instruction. As an alternative to perceptual triggers, imagery-driven thin education lays its foundation on the retrieval of prior sensory learning experiences in form of mental imagery. More precisely, as the brain grows and the neural networks become more complex in adults, mental images can generally be evoked from unisensory inputs including auditory or visual (Halpern & Zatorre, 1999). In response to imagery-provoking input, an assembly of neurons linked as a result of previous sensory experiences, are activated to help understand abstracted dependencies or experiences without sufficient sensory stimuli. Yet, in order to polish up imagery-deficient instructions and enable learners to move on to thick education, a pair of *thickening strategies* (i.e., *real* and *virtual*) are set forth. Pishghadam (2018), delineates that, while instructions high in sensory incentives, as an indication of what he calls thick education, inherently activate sensory-specific perceptual brain regions, instructions high in sensory imagery encourage individuals to generate different types of mental images. Needless to say, the idea of thin education is not at all intended to either replace or reject the five senses approach to education; rather, it is put forward to expand the view through equating the cognitive processes underlying perception with imagination.

Taken together, the major objective of this study is to propose a dual-continuum model of sensorial education along with a pair of thickening strategies to advance from thin toward thick education. In order to have full-fledged understanding of the underlying mechanism of the newly proposed paradigm, we present an ample review of multisensory teaching and multisensory imagery as two instrumental concepts.

2. Multisensory Teaching

Effective teaching, with student engagement and achievement as its defining characteristics, has always been discussed as one of the underlying challenges facing teachers (Baines, 2008). Over the years, sensory and multisensory strategies have been employed by teachers and educators, believing that senses, either in isolation (unisensory) or in combination (multisensory), provide opportunities that allow for inclusive learning (Katai, 2011). Defined as a way of teaching harnessing more than one sense at a time, multisensory instructional approaches are employed to embellish instructional materials, enrich learning environments, and strengthen the human-nature nexus (Auer, 2008). Pursuing the major premise of multisensory teaching, teachers use hands-on activities, typically engaging learners' kinesthetic, visual, and auditory senses. Concurrently, they need to draw the students' attention to the activity they are involved in, or the information communicated would fade away instantly (Baines, 2008).

Multiple-senses techniques have been originally designed for learners affected by dyslexia, dyscalculia, and autism, or those experiencing various mental disabilities such as adults with Alzheimer's disease (Katai & Toth, 2010). Yet, its benefit to learning is not limited to those needing special services only. In non-therapeutic settings like classrooms, sensory involvement not only makes learning more enjoyable by providing countless memorable learning experiences, but it also reinforces the lessons learned from narratives by reducing unnecessary cognitive load (Baines, 2008). According to the learning pyramid developed by the National Training Laboratory, individuals retain 5% of what they hear, 10% of what they read, and 20% of what they see. However, if the involved senses function cooperatively, the retention rate increases to a considerable extent. There is growing evidence that (e.g., Mayer, 2001) multimedia, as a multisensory source of information, brings about deeper leaning as compared with verbal-only materials. Drawing upon the principles of dual coding theory (Paivio, 1971), verbal information can enhance if presented along with relevant visual images. The five senses approach endeavors contribute to literacy and language-related fields as well. As Kalivoda (1978) puts it, drills which involve learners' senses of hearing, vision, and touch give rise to their comprehension of the foreign language. A further benefit of multisensory could be that it provides equal chances for the students with dominant senses (Katai, 2011).

The recent explosion of interest in the interplay between multiple senses and the rapid development of the field of multisensory research are mainly grounded in the new brain research findings (Katai & Toth, 2010). The unimodal approach to sensory processing dominated the studies in cognitive neuroscience during the 19th and 20th centuries. However, more recent studies in this area have steered the focus from reductionism toward Gestalt methodologies, maintaining that although senses have independent structures, they are designed to work in harmony (Katai, 2011). Accumulating neuroimaging reports revealed that, human brain functions perfectly in the environments where a broad spectrum of sensory streams obtained from different modalities converge onto individual neurons in the nervous system. These neurons fire on the condition more than a single modality is activated in co-occurring events (Shaywitz, 2003). In an experimental study, James (2007) used fMRI to objectively investigate brain activity in a group of preschoolers. During the first phase of the study, the activation of visual neural structures was observed as they only looked at some letters and visual stimuli. As for the second phase, the children were helped to recognize the letters and write the letters to use visual, auditory, and kinesthetic modalities together. Subsequently, their brain was imaged while looking at the letters again. This time, motor areas of the brain were similarly activated although they had no writing movement.

The bulk of sensory input received through different modalities could lead to the formation of greater neural connections in sensory-specific cortical areas. Most traditional research assumed that, sensory constituents of perception including vision, hearing, taste, smell, and touch undergo independent processes in the brain. However, later, it was discovered that the content of the incoming signals could be modified through the integration of information both within (i.e., unisensory integration) and across modalities (i.e., multisensory integration). Building upon the modern study of perception and principles of Gestalt psychology, advocating a holistic view to the operation of the brain, the apparently chaotic sensory streams are not perceived as sum of their individual components but as a structured whole through the perceptual systems of the brain (Lin, 2004). Unlike classic modular approaches, recent discoveries have uncovered zones of neural convergence for multisensory combined information in cortical and subcortical areas such as the superior colliculus (Kaas & Collins, 2004). Several fMRI studies have reported that multisensory interplay not only involves the traditionally known multisensory regions (such as the occipito-parietal and the occipito-temporal borders) but it also activates the multisensory convergence zones close to the low-level sensory-specific regions (Driver & Noesselt, 2008). The cross-modal effects generated by the sensory cues may, as a result, be multiplied, disambiguated, vetoed, or inhibited depending on the congruency of the presented stimuli (Schreuder, van Erp, Toet, & Kallen, 2016).

Although multisensory teaching, or what we technically refer to as thick education, is a valuable asset, especially in contrast to the current practices of teaching to the test, it is not always possible to put senses into practice. Apart from lack of time and the inadequacy of facilities and equipment, there are times that the students have no real world reference for the concepts they are supposed to learn (Dede, Salzman, Loftin, & Sprague, 1999). Not only that, critical thinking or any act of higher reasoning, transcends the boundaries of the five senses, chiefly depending on amalgamating different chunks of information available through prior sensory experiences stored in ones' long-term memory (Auer, 2008). To compensate for the pedagogical deficiencies, the current paper argues for the significance of designing a dual-continuum model of sensorial education incorporating sensory imagery to make up for the impracticalities of the five senses approach. In the following section, the concept will be reviewed comprehensively.

3. Multisensory Imagery

The idea of mental images, often remembered as quasi-perceptual experiences, traces its historical roots in Plato's Theaetetus (369 BC), concerning the nature of knowledge, and Aristotle's De Anima (359 BC) centered on soul and body relations, perception, and thinking. The scientific inquiries of this omnipresent phenomenon initiated in the late 19th century with Sir Francis Galton's (1880) efforts to empirically probe the impression of mental imagery on thinking, through his so-called 'breakfast table' visualization test. The popularity of the concept soon multiplied as numerous investigations oriented toward uncovering the role of imagery in reasoning. Converging evidence from a subset of experiments led researchers to commonly agree that mental images, as a means of contemplation, resemble real, visual perceptions except that they are prompted by the mind rather than the retina (Lacey & Lawson, 2013). These conceptual views were given a new life during the cognitive revolution following behaviorism. With the advent of non-invasive neuroimaging tools and brain stimulation paradigms, the subjective phenomenon of mental imagery was more scientifically verified through neural correlates, providing complementary evidence to traditional observations. As an instance, evidence from noninvasive neuroimaging confirmed that some types of neurons are responsible for both visual stimuli and visual imagery of the corresponding stimuli. However, "visual mental images are much fainter than percepts" (Ganis, 2013, p. 23).

The underlying premises of the cognitive approach modified some of the basic assumptions which heavily relied on behavioral outlooks. As for one, imagery was traditionally associated with the visual perception due to its dominance over other modalities; yet, during the last few decades, it was revealed that it could also be generated from non-visual modalities (Lacey & Lawson, 2013). Generally speaking, the vast majority of our sensory representations are, in fact, visual. In every single sensory interaction with the immediate environment, our brain constructs a visual mental representation of the external object or event which can later be reactivated in long-term memory in the absence of the corresponding external stimulus (Kosslyn, Ganis, & Thompson, 2001). The constructive facet of mental imagery transcends mere reactivation of previous perceptual experiences by parsing and reassembling the fragments of sensory information in new ways (Finke, Pinker, & Farah, 1989).

Although the rapidly expanding field of cognitive science has given rise to more detailed theories and numerous research papers scrutinizing visual mental imagery, only a handful of scientific studies have investigated modalities other than vision. The body of research on auditory imagery typically focuses on the way structural and temporal properties of auditory stimuli (e.g., rhythm, loudness, melody, pitch, etc.) are stored in and retrieved from the long-term memory (Lacey & Lawson, 2013). Gustatory and olfactory representations, captured as "tasting with the mind's tongue" or "smelling with the mind's nose", share some commonalities with corresponding perceptual mechanisms (Bensafi, Tillmann, Poncelet, Przybylski, & Rouby, 2013, p. 77). Using positron emission tomography (PET), Djordjevic, Zatorre, Petrides, Boyle, and Jones-Gotman (2005) alleged that, consistent with the studies of visual imagery, imagination of odors stimulates primary and secondary olfactory cortices. The scarcity of insight into the 'inner tongue' lies in its complex, combinatory nature. Food experiences are indeed an amalgam of taste, odor, and texture which makes it rather infeasible for researchers to decompose and identify taste independently (Lacey & Lawson, 2013). Like gustatory imagery, the mental representation generated from the sense of touch has not thus far been the topic of interest to the scientific community due to its limitations derived from integrating different skin sensations such as proprioception, pressure, and pain rather than mere manual interaction with the object. Some assume that the tactile mental imagery shares similarities with visual imagery. Given this similarity, they believe that, during the process of generating images on the basis of tactile information, in the majority of cases, visual representations may be used instead (Uhl et al., 1994).

Motor imagery is, in fact, internal recurrence of a movement without execution. There exist numerous studies (e.g., Guillot & Collet, 2005), using electromyography (EMG) recordings, confirming or rejecting the hypothesis that motor imagery prompts muscle activity. The literature on motor imagery revealed that imagining a movement or action observation via mirror neuron systems evokes those parts of the motor cortical networks (i.e., the supplementary motor area and some parts of the premotor and parietal cortices) responsible for executing the movement, yet to a lesser extent (Decety & Jeannerod, 1996).

There have been several views concerning the active brain regions in perception and imagination. Some postulate that imagery involves the brain regions used for higher-order cognitive functioning. Yet, the large majority of these studies (Farah, 1989; Kosslyn, 1994; Kosslyn, Thompson, & Ganis, 2006) put forward that sensory imagery and sensory perception activate many common cortical areas and pathways such as the early sensory cortex, advocating the theories on 'grounded cognition' (e.g., Martin, 2007; Meyer & Damasio, 2009). It is actually believed that mental representations, and in particular, visual mental imagery, engage similar brain regions through similar neural processes with a substantial overlap of more than 90% with the real sensation (e.g., Ganis, Thompson, & Kosslyn, 2004; Kosslyn,

2005). Therefore, 'seeing with the mind's eyes' provides a mental representation whose characterization is, to a great extent, in common with that of perception (Ganis, 2013).
Overall, the vividness of perceptual representations and the possibility that stimuli can coalesce with former representations within the long-term memory is characterized by multisensory rather than unisensory triggers (Lacey, Pappas, Kreps, Lee, & Sathian, 2009). The ability to construct vivid mental imagery is likewise derived from inter-individual variations determined by biological features (e.g., short-term memory capacity), language, or experience plus the dominant modality of the stimuli. That is, for some objects, tactile properties may carry more important information than the visual features. These differences could be clearly observed in Galton's (1880) breakfast table test. The reports from 1500 participants, concerning the way they could visualize their breakfast table, varied from very vivid pictures of the breakfast to no imagery at all.

Juxtaposing the overviewed principles of multisensory teaching and multisensory imagery, in the following section, we will sketch out an inclusive, dual-continuum model of sensorial education, targeting at making formal education more efficient by investing in previously stored sensory experiences and granting additional weight to sensory imagery.

4. A Dual-Continuum Model of Sensorial Education

Recruiting senses in education has long been endorsed by a multitude of leading experts in the field, under the broad idea of multisensory education (e.g., Auer, 2008; Baines, 2008; Katai, 2011). As the name implies, involvement of the senses deepens students' understanding, resulting in enhanced academic achievement. In order to break the concept down and hold a more detailed view of the role of senses in education, we put forward a dual-continuum model of sensorial education, comprising thick and thin education (Figure 1).

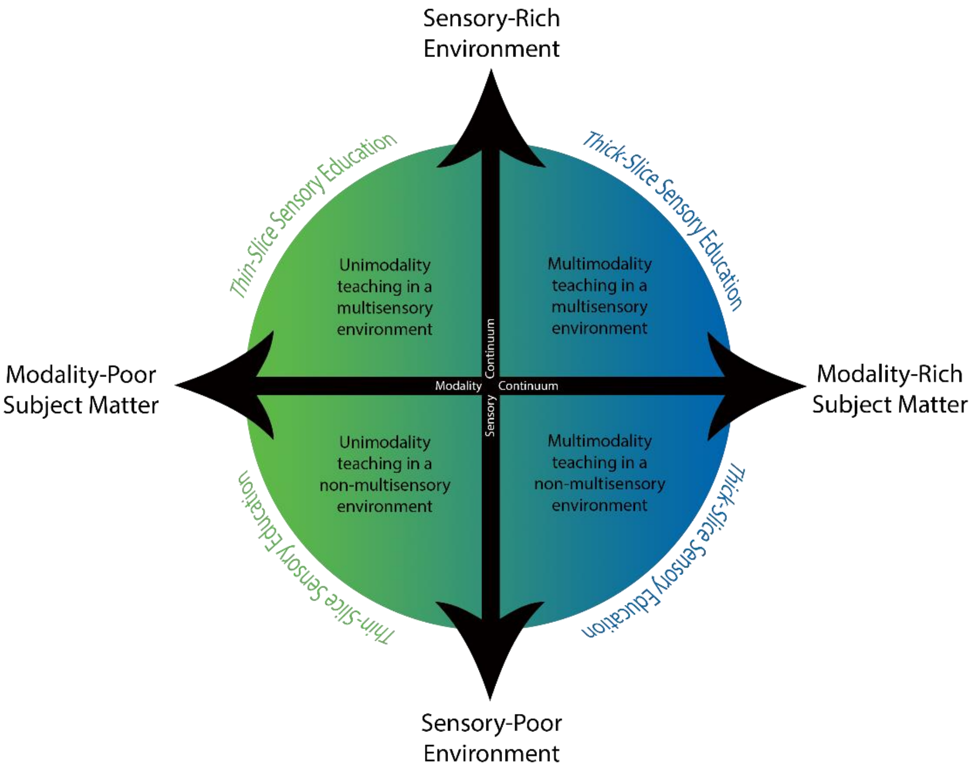

Figure 1

Dual-Continuum Model of Sensorial Education

To delineate the two proposed terms, which vary in concreteness, we first need to make a distinction between 'sense' and 'modality' as the keywords which have thus far been used interchangeably in the literature of multisensory education. Given that the term 'mode' is largely employed in educational contexts and in relation to information transfer activities (Schmidt, 1990) and 'sense' is typically identified with environmental experiences derived from using the five senses, we associate 'modality' with subject matter instruction and 'sense' with classroom setting. To clear up their independent roles in education, we coin the term *modality education* to stand against *sensory education*.

Sense and modality, within this model, are treated as two independent, yet interrelated, continua, each of which ranges from 'rich' to 'poor' depending on the variety of sensory triggers incorporated into the teaching content or environment. A sensory-rich environment reflects itself in a classroom supplied with bright colors, background music, pleasant odors, and proper lighting which help maintain attention and concentration. A modality-rich subject matter instruction, on the other hand, relies heavily on teachers practicing hands-on activities and content-related sensory experiences rather than lecture-based teaching methods in the classroom.

The interaction between the continua provokes four different approaches to sensorial education with ‘multimodality teaching in a multisensory environment’ as the ideal form. To elaborate, based on ‘multimodality teaching in a multisensory environment’, teachers make use of different objects and instruments, corresponding to the content, to promote multimodal perception of the subject matter. This takes place in a classroom surrounded by multiple sensory stimuli such as the one set up according to the principles of suggestopedia (Lozanov, 1979). Yet, this multimodal perspective could take effect in a classroom where the seats are broken or the ventilation system is not working, as a manifestation of ‘multimodality teaching in a non-multisensory environment’. By contrast, learning under the assumptions of ‘unimodality teaching in a multisensory environment’ could come about when, like university classes, the teacher uses lecturing as the only delivery mode in a classroom supplied with natural light, fresh air, comfortable seats, and so forth. This unimodal way of instruction may be observed in a class that ignores the learners’ sense of physical comfort or their most basic perceptual needs (i.e., ‘unimodality teaching in a multimodal environment’).

Considering the prevalence of instruction over environmental features, we bring it into play as a yardstick to divide the model into half, designating thick-slice and thin-slice sensory education. The blue half captures traditional uses of multiple modalities in sensory-rich or sensory-poor educational settings, whereas the green half, serving as the backbone of this model, contrives to incorporate multiple senses into a single modality. It goes without saying that, educators may look at the latter dimension as unworthy of instruction irrespective of the notion that this form of didactic pedagogy is likely to enable the cultivation of higher-order thinking skills and mental imagery besides accelerating the process of teaching and learning.
While both thick and thin education are present in the educational system of every country, it is necessary to bridge the potential gaps which hinder the learner’s chance of experiencing thick understanding. Owing to a bundle of previously mentioned limitations, application of thick education paradigm may not be desirable on occasions. Therefore, thin education is the

alternative which is practicable. This mode of education could be of two distinct types including *imagery-driven* or *imagery deficient*. The imagery-driven aspect could be rich enough to reinforce the achievement of academic success. Yet, *thin cognition* as a byproduct of *thin understanding* may be the consequence of an imagery-deficient type of unimodal instruction which does a poorer job of involving learners' mental representations. To make amends and promote from thin to thick education, different *thickening strategies* are set forth. The so-called strategies are either *real* or *virtual* in nature (Figure 2). The real one conforms to the principals of thick education by making use of the five senses to enrich the subject matter instruction with relevant sensory experiences. The virtual thickening strategy, on the other hand, takes advantage of visualization and prior sensory learning experiences reflected in imagery-induced information to make the brain fill out the missing sensory input required to reach *thick understanding*.

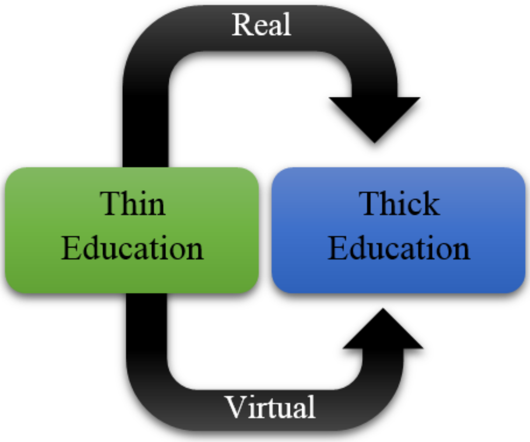

Figure 2

Thickening Strategies

Blending the boundaries of unisensory and multisensory integration (Alvarado, Vaughan, Stanford, & Stein, 2007; Young, Fenwick, Lambe, & Hogg, 2011), we are of the opinion that, in imagery-driven thin education, mental representations across different modalities integrate within a single modality which, in our model, is the auditory channel. The input from this channel is initially parsed in the brain for imagery cues whose congruency modifies conception. The interplay of these cues yields an estimate of the concept which is comparable to the one obtained from the collaboration of multiple modalities. Lending support to the practical features of thin education, neuro-imaging findings similarly indicate that sensory information stored in multiple sensory regions of the brain is activated even though stimulation has been done through one modality only (Goswami, 2008). Although in every lecture or pedagogical instruction some information may come new to the brain, it is able to encode the new input by wiring previously distinct parts of networks or forming new neural connections based on similar neural structures generated before.

To execute this dual-continuum model, a constellation of elements seem worthy of consideration. First and foremost is that, as an alternative educational hypothesis, thin education could better apply to adults owing to their more complex experience-dependent cortical connections which have been shaped and reshaped, to a considerable extent, in response to previous life experiences including language, culture, job, and education (Pantev et al., 1998). Basically, as we learn new information, new neurons are integrated into the preexisting hippocampal circuits, forming additional synapses. The complexity of these synapses and the involved neural networks increase as we learn more, making us able to discern and contemplate on more abstract concepts (Goswami, 2008). Moreover, the efficacy of the thickening strategies depends largely upon a set of mediating features including different types of intelligence. As for real strategies, the role of time and facilities is absolutely undeniable. Concerning virtual strategies, narrative intelligence (NI), as a must-have skill, manipulates the competency of teachers in illustrating a full-fledged scheme of a concept (Pishghadam, Golparvar, Khajavi Fadafan, & Iranrad, 2011). Teachers with a high level of NI could better organize the sequence of materials so as to create an enhanced imagery context. Their verbal intelligence (VI), likewise, helps improve the imagery context by proper use of language.

Concluding Remarks

The optimal suitability and success of conventional multisensory teaching, or what we call thick education, has been investigated through years of research (Katai, 2011). Yet, in order to overcome the likely limitations of this mechanism, we propounded a dual-continuum model of sensorial education. The model takes on several forms and dimensions, advancing from education of the senses to abstract thinking. It actually defines itself in creating an environment enriched with sensory cues or/along with pumping some sensory flavors into the subject matter instruction.

The overall role of this model in systematizing the field is absolutely indisputable. In order to put the model into practice, teachers need to take the following notions into account:

1. They should be conscious of the purported classification between multimodal and multisensory teaching and cater for both. Drawing a line between senses and modalities sensitizes teachers that recruitment of senses in the instruction or environment leads to different results which, in the end, alters learning outcomes.
2. Choosing between thick or thin education depends on who the learners are, where the location is, and what you intend to teach. That is to say, there exists no one-size-fits-all policy. Building upon the promise held out by thick education, learning is optimized when sensory modalities function during the course of knowledge transmission. Principles of learning brought to light by thin education, in turn, entail that thick understanding may not be constrained by the implementation of the five senses. To borrow from Pishghadam, Shayesteh, and Adamson (2013), both of these strategies are directed toward creating similar sensory emotions (coined as emotioncy) induced from optimal learning.
3. In deprivation of perceptual experiences, the critical role of imagery is spotlighted. In order to promote students' grasp of the concepts in such a situation, the instructional narratives have to be replete with imagery triggers. To make efficient use of imagery, however, teachers need to render abstract entities into concrete sensory-driven symbols to awaken prior real life experiences recorded in different regions of the brain. In brief, thin education, produces the best results, only if sensory imagery features are built in.
4. The necessity to optimize the atmosphere of the classrooms and making it a popular area is now felt more than ever. Sensory teaching, as opposed to modality teaching, places its emphasis on the environment only. Despite having an indirect influence, the contribution of the setting to maintain comfort and, therefore, concentration cannot be ignored.

Overall, the model offers a promising avenue to the study of multisensory teaching. At the level of instruction, it could serve as a source of inspiration for developing new didactic strategies including emotioncy-based language instruction (EBLI), depending on the learners' goals and needs. This teaching guide is equally apt to have salient implications for teachers and adult learners in particular. It actually raises teachers' awareness of unimodal and multimodal teaching instructions, making them able to fill the missing sensory information with mental representations. Typically, in terms of scientific concepts, learners may tend to receive more information in less time through a single modality rather than spending dramatically more time on involving their senses. Most scientific abstractions could be instructed through the imagery-driven dimension of thin education as an ameliorated sketch of conventional unimodality training protocols. Besides educational contexts, the model could provide guidance for people with alternative scenarios to give a speech.

Last but not least, the multisensory facilitation of unisensory learning could be limited from different aspects. As for one, although the new model is applicable to various teaching situations, its unimodal aspect needs particular expertise. Teachers recruited for this purpose are suggested to be checked for their NI and VI besides other behavioral requirements. Therefore, only certain teachers are able to pass the initial screening. Learners having a developed imagination to discover meaningful imagery patterns are granted an additional privilege. It is also crucial to bear in mind that thin education is not the ideal mode of instruction, but is an efficient way which may come in handy in specific situations and in dealing with particular groups of learners with certain academic needs. While the literature lends support to thick education, thin education calls for further investigations. It is highly recommended that future studies carry out experiments that empirically substantiate the efficiency of the model we presented. A further intriguing issue for future research could be to extend the model beyond the one suggested here. Other shortening strategies apart from sensory imagery could be an impetus for complementary studies in this area.

Acknowledgments
We gratefully acknowledge the supports of the Iran's National Elites Foundation (INEF), the Cognition and Sensory Emotion Lab, Ferdowsi University of Mashhad, and a grant-in-aid of research from the Cognitive Sciences and Technologies Council (CSTC) in 2016 (contract code: 4285).

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