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An Analysis of Research Trends in Brain-based Learning in Adult Education and HRD Fields: The Content Analysis and Network Text Analysis

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Abstract: The purpose of this study is to address the trends of the research on brain-based learning and to present an integrative theoretical framework to provide new insights and future directions in adult education and HRD fields. Based on the neuroscientific perspective, the implications of which the ways to conceptually broaden educational research and practice were discussed.

Keywords: Brain-Based Learning, Research Trends, Content Analysis, Network Text Analysis

Introduction

Thanks to advances in modern technology in visualizing tools to monitor inside the human brain, such as magnetic resonance imaging (MRI), functional MRI (fMRI), and positron-emission tomography (PET), we have been able to analyze and understand how the brain works (Jansen, 2008). Since the brain sciences achieved significant advances in understanding how the brain functions and how we learn, from the early 2000s, many educators are pursuing to investigate how we can use neuroscientific findings to improve teaching and learning practices (Tommerdahl, 2010). In more than the past two decades, tremendous attempts have been made to identify complicated processes of brain functions for cognition and learning. These efforts have generally focused on comprehending the vastness, complexity, and potential of the brain in an educational context with scientific evidence of the anatomical intricacies of brain functions. Additionally, there has been a wealth of empirical studies conducted to identify the cognitive processes and psychological construct in neuroscience. However, some critiques argue that we carefully explore the link between brain science and education and should be cautious and prudent in interpretations (Jensen, 2007) since these educational applications are limited in providing sound data verifying whether the educational practices generate the desirable change in the brain structure or such changes influence human behavior and learning.

In this context, a comprehensive review of the current research on brain-based learning (BBL) is highly required not only to guide empirical and scientific directions for future studies but also contribute to developing a theoretical framework for understanding the educational phenomenon from the lens of neuroscience. The purpose of this study is to critically examine the trends of the research on BBL and present an integrative conceptual framework about the connection between neuroscience and learning. To address the purpose of this study, we reviewed the current literature on BBL which is performed in the adult education and human resource development (HRD) fields. Based on the findings of the study, we provided implications and directions for future research and practical applications.

Literature Review

The Concepts of Neuroscience and Brain-based Learning. The recent progress in neuroscience that explores functions and processing in human brains, especially by neurons and synapses, has enabled education scholars to develop deeper understandings of the learning process. The brain-based approach to learning attempts to apply knowledge of neuroscience into

educational practice to enhance the learning effectiveness (Gülpinar, 2005). The BBL is based on constructivist approach, focusing on aspects of human brains such as "individual difference", "contextuality (interconnectivity)", and "complexity" (Gülpinar, 2005, p. 299). That is, learning and cognitive development is a process that learners construct and build their knowledge, especially by actively engaging in learning and their learning is considerably situated and contextual. It is, thus, important to consider learning conditions and contexts as well as understand the functions and processes of the human brain although an individual's brain processing primarily depends on his/her learning style.

Research and Practices on Brain-based Learning. With the growing interest in analyzing human brain, the BBL research in education has developed during the 1990s. The early research is primarily interested in the disabled (Bellah et al., 2008), for example, dyslexia and dyscalculia, in order to support their learning. Yet, the BBL research currently expands its interest into more diverse areas with more improved neuroscientific knowledge and technologies. These scholarly efforts have consequently produced the BBL models and strategies which share common principles; the human brain functions as individualized and specialized but holistic and integrated, calling for needs of more diverse and creative learning experiences and environments. For example, Hilleman (2006) emphasizes a significance of interconnectedness of body, brain, and mind and contend that effective learning can occur when incorporating physical movements into learning, facilitating emotional engagement, and using visual learning aids.

The fields of adult education and HRD are also seeking new possibilities and understandings for effective learning for adults. Though presumably in the post-development phase, a brain of adults can learn and change, given the plasticity of the brain (Taylor, 2006). Particularly, experiences that adults accumulate throughout their whole life are resources to facilitate and expand their learning (Cozolino & Sprokay, 2006). Understandings of adult brains can, thus, contribute to developing effective learning strategies for adult learners and helping them overcome their learning barriers. Furthermore, scholars stress that adult learners do not follow the same learning process and pathway, but various factors including past experiences and brain structure influence learning capacity and preference of the adults (Knowland & Thomas, 2014). It is important to provide appropriate learning environments for adult learners.

Methods

To collect articles, this study performed a targeted search of studies that are relevant to the research purpose. Two steps of searching for articles were processed. Firstly, we searched academic journals in multiple online databases including *Google Scholar*, *EBSCOhost*, and so forth. In searching relevant literature, we comprehensively used a list of keywords such as "brain-based learning," "neuroscience of learning," "educational neuroscience," and "educational neurology," within the search titles and keywords. Secondly, by checking the references of the initially obtained articles, we found additional studies. In this research, we used keywords as units of analysis which are elicited from the collected literature.

In this study, two research methods to analyze the data were employed: (1) content analysis and (2) network text analysis. Content analysis is one of the commonly used methods in various fields of studies to analyze communication messages including text document, visual, and verbal content. Content analysis is a systematic research method to understand and describe phenomena providing new knowledge and insights by enabling researchers to make objective, but content-sensitive inferences based on data (Krippendorff, 1980). Duriau, Reger, and Pfarrer (2007) emphasized that content analysis can present a rich description and meaning of

phenomenon with robust statistical analyses by combining qualitative and quantitative approaches.

Network text analysis refers to a series of approaches to discover networks and connections of concepts from the texts and linked words (Diesner & Carley, 2005). Networks uncovered by network text analysis reveals the implicit structure of the meaning and concepts in the text. The underlying assumption of network text analysis is that words and relations among them can form knowledge (Sowa, 1983). In addition to extracts complex network structure in texts, this method can analyze a large amount of text data efficiently and produce a network map visually representing the relationship and proximity of texts (Popping, 2000).

Findings

Content Analysis. Total 165 peer-reviewed journal articles published between 1985 and 2019 included in the content analysis were analyzed along the following three dimensions: Chronological classification, thematic classification, and methodological classification.

Chronological Classification. In order to examine chronological research trends, collected literature was classified by the units of the decade (1980s, 1990s, 2000s, and 2010s). The chronological distribution indicates that the first research on BBL in the adult education field was witnessed in 1985. Since then the academic interest has continuously increased, and particularly, the quantity of research was explosively expanded in the 2010s. It is likely that educational neuroscience and more broadly *Mind, Brain, and Education*, a newly emerging discipline, played a pivotal role to apply it into adult education research and practices since the 2010s (Fisher, Chin, & Klitzman, 2010).

***Thematic Classification*.** In accordance with the thematic classification of Cho and Kang (2016), collected literature was analyzed by the following sub-themes: (a) basic research on the learning, cognition, and brain, (b) research on the understanding of the learner/learning processes, (c) research on the brain-scientific interpretation and its educational implications, and (d) research on the brain-based teaching method. The thematic distribution is illustrated in Table 1 in detail.

These findings show that the majority of articles were primarily focused on interpreting educational phenomenon based on neuroscientific perspectives and/or presenting theoretical implications and remedies for improving educational practices by integrating previous brain-based research findings. The research included in this area might serve as a pipeline for the consolidation of former adult education theories by bridging the gap between neuroscience and education fields. In addition, the second thematic area on teaching method presents educational practice-oriented approaches about the effectiveness of brain-based teaching/learning method through the application of neuroscientific findings into actual adult education programs or HR practices. On the other hand, research on the basic analysis of adult brain and adult learner/adult learning processes were limitedly performed (see Table 1). It mirrors that the current neuroscientific approach on education has given greater attention on special education and early childhood education fields since analyzing brain functions was expected to contribute to identifying the individual developmental cognitive process targeting this population.

Table 1. *Thematic Classification (Frequencies/Percentage)*

Learning, cognition, and brain	Understanding of the learner/learning processes	Neuroscientific interpretation and its educational implications	Brain-based teaching method
24 (14.5%)	22 (13.3%)	82 (49.7%)	37 (22.4%)

Methodological Classification. The methodology employed in each research was used as the unit of analysis. Table 2 presents the methodological classification of the selected papers. As illustrated, the finding shows that a majority of the studies (67.3%) focused on related literature analysis to suggest educational implications in adult education and workplace learning practices based on neuroscientific approach. This implies that many BBL research has stressed the importance of building educational theories and presenting new insights about teaching and learning.

Table 2. *Methodological Classification*

Quantitative research	Qualitative research	Mixed-methods research	Literature research
37 (22.4%)	11 (6.7%)	6 (3.6%)	111 (67.3%)

Network Text Analysis. Network text analysis was conducted with 324 nodes which are extracted from 828 keywords identified from the selected studies. In this section, findings from network text analysis including influential keywords in each group and network map representing the relationships of the core keywords are presented.

Identification of Groups. Table 3 lists frequency and degree centrality scores of the core keywords in the four groups which are represented in the network map. More specifically, group 1 consists of keywords that are closely related to neuroeducation, including *neuroscience*, *educational practice*, *instructional strategies*, and *learning performance*. Group 2 includes an emerging keyword such as *neuromyths*. Group 3 is composed of keywords reflecting adult education theories and practices, including *adult learners*, *training & development*, *experiential learning*, *neuroplasticity*, and *learning environment*. Group 4 has more adult education related keywords, such as *learning styles* and *professional development*.

Table 3. *Methodological Classification*

Group	Keyword	Frequency	Degree centrality	Group	Keyword	Frequency	Degree centrality
1	**Neuroscience**	30	**1.553**	3	**Adult Learners**	16	**1.489**
1	**Educational Practice**	14	**1.064**	3	**Learning**	19	**1.106**
1	**Education**	17	**1.000**	3	Brain Functions	12	.957
1	**Cognitive Neuroscience**	14	**1.000**	3	Training & Development	12	.872
1	Emotion	8	.830	3	Experiential Learning	10	.851
1	Instructional Strategies	11	.681	3	Neuroplasticity	10	.787
1	Neuroimaging	9	.638	3	Simulations/Games	9	.723
1	Learning Performance	8	.638	3	Memory	6	.553
1	Brain Development/Changes	8	.596	3	Learning Environment	5	.511
2	**Neuromyths**	16	**1.064**	4	Learning Styles	10	.638
				4	Professional Development	7	.511

Note. Keywords are sorted by degree centrality scores of 0.5 or higher. Keywords in bold face serve as the connector between other keywords in each group.

Influential Keywords in Each Group. Figure 1 depicts each group reflecting the relationships of the core keywords in the network text analysis. In group 1, *neuroscience*, *educational practice*, *education*, and *cognitive neuroscience* have higher degree centrality scores than others implying they play a central role in bridging all other keywords. Additionally, it can

be interpreted that the research studies in group 1 are mainly focused on examining the relationship between neuroscience and education from a broader viewpoint. Keywords in group 2 are less dense and less tied to each other, in comparison with group 1 and 3. In this group, *neuromyths* serve as the most influential keyword and it is associated with *dyslexia*, *language learning*, and *learning disorders*. It implies that the papers contained in this group are performed with prescriptive purposes to improve the learning outcomes of adult learners who have mental difficulties in learning. *Adult learners* and *learning* are emphasized as central connectors in group 3. They are associated with more detailed keywords such as *training & development*, *experiential learning*, *neuroplasticity*, *simulations/games*. It represents that the research included in this group are typically aimed at the application of neuroscience into the adult education practices by the examination of brain functions/structure. Finally, group 4 was composed of less dense and less tied and there are no representative keywords serving central connector, given the degree centrality scores. This implies that research in group 4 has been less explored, compared to other groups. *Learning styles* and *professional development* are the most influential keywords and these are closely connected to *counseling*, *leadership development*, *organizational development*, and *organizational performance*.

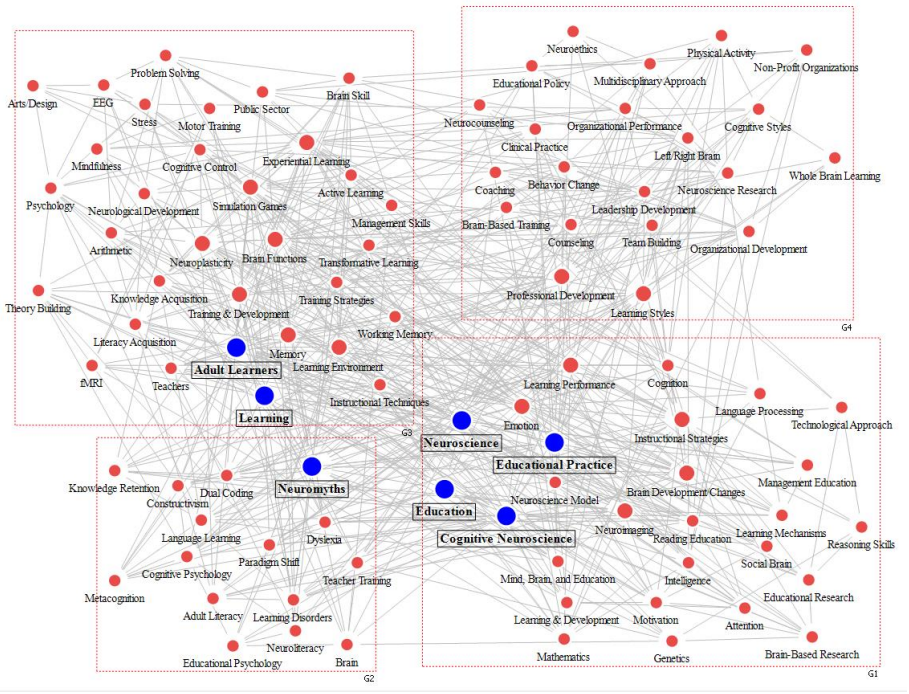

Figure 1. *Core keyword network*

Note. The node size indicates the degree centrality of each keyword and blue-colored nodes represent core keywords scoring 1.0 or higher degree centrality.

Discussions and Implications

For the thematic classification of the studies, about half of them were interested in the application of neuroscientific findings to advance learning theories and improve educational practices. This theme is aligned with the major finding of neuroplasticity which is the brain's capacity to continuously adapting synaptic networks in response to the challenging environment and new experiences. It also supports that a multidisciplinary approach is strongly recommended to integrate neurobiological research on brain development and educational research on adult learning and development in order to improve current practices in various educational efforts in school and organizational settings. Findings from keywords network analysis reiterate the major theme in thematic and methodological classification findings: the importance of connecting neuroscience, educational practice, adult learning, and cognitive neuroscience. One unique finding, however, is that many researchers (in 16 studies) stressed the criticality of addressing

neuromyths persisted in schools and colleges, which are distorted scientific facts about BBL. Some researchers claimed that these neuromyths have been used to justify ineffective approaches to in instructional practices (Howard-Jones, 2008). It is a welcoming phenomenon that recent studies in neuroscience reveal more precise facts about brain structure and functions so educational practitioners can appropriately apply authentic neuroscientific findings to their instructional practices.

Another important keyword found from the network analysis is emotion. It is acknowledged that traditional approaches of instructional practices have been heavily depending on cognitive and behavioral learning approaches and methods. However, the affective aspect of learning looks to catch the attention of many educational researchers recently. Affective neuroscientists elucidate that emotion is a very central moderator of memory process including cognition, attention, and learning. When the amygdala is heavily charged with negative emotion, it leaves little resources to perform other memory functions such as encoding and retrieving of information. This becomes an important fact explaining why instructors should facilitate a positive learning environment to allow more functional activities of the frontal cortex for memory processing through the less charged amygdala.

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