Review Article

Neuroleadership as an Asset in Educational Settings: An Overview

Evgenia Gkintoni [1*], Constantinos Halkiopoulos [1], Hera Antonopoulou [1]

[1] *Entrepreneurship and Digital Innovation Laboratory (EDI LAB), Department of Management Science and Technology, University of Patras, Greece.*

Abstract

Objectives: The goal of this research is to investigate the scientific basis for integrating neuroscience in general, and cognitive neuroscience in particular, into the field of educational leadership. In recent decades, the scientific community has shown a great interest in integrating neuroscience into higher education and the many levels of leadership education and decision-making that are crucial to a range of educational difficulties that leadership leaders are called upon to handle. *Methods/Analysis*: The present effort involves a systematic review of research publications published in the preceding two decades after a keyword search of reputable international databases. This review incorporates papers from Scopus, PubMed, Elsevier, and PsycINFO databases. The terms neuroleadership and education were used in combination with the four subfields outlined in the research: Among them are decision-making and problem-solving abilities, emotional control, cooperation and influence with others, and facilitation of change. *Findings*: The review's results underscore the vital relevance of neuroscience integration into educational leadership difficulties and highlight ethical concerns regarding its deployment in educational settings. *Novelty /Improvement*: The novelty of this work is that it conducted a review of the literature on neuroleadership using a combination of executive function parameters, more precisely cognitive flexibility, decision-making, problem-solving, emotional regulation, the mirror neuron system, and behavioral data from studies conducted in educational and administrative settings.

1- Introduction

1-1- Integration of Neuroscience in Leadership and Education

Various researchers have been interested in the study of neuroscience and its relationship to leadership for decades as they seek a framework that underpins leaders and organizational performance. The study of neuroscience and its influence on human behavior and reaction systems compels educational leaders to delve deeper into human dynamics and their impact on defining an organization's culture and mission [1]. In addition, educational leaders may use brain research to tap into other people's abilities and grow and train their brains via effective communication. This is characterized by a high degree of social, emotional, and cultural intelligence. Numerous studies have illustrated various types of leadership and specifically referred to transformational leadership as an effective leadership style [2]. According to Bass, transformational leadership entails four critical qualities of the leader: i) charisma; ii) inspiration; iii) spiritual development, and iv) a customized strategy. Various researchers in the fields of educational research and organizational management point to certain changes in the profile and requirements of executives that must be met in order to conduct effective leadership. An effective leader must prioritize values shared by his subordinates, seek their education and growth, and promote a common vision and purpose. Furthermore, an effective educational leader possesses qualities

---

that foster collaboration, problem-solving abilities, and an ability to adapt to change. Nonetheless, effective educational leaders demonstrate empathy and a genuine interest in people as humans, not simply as employees. According to Mayer et al. (2000) [3], an effective (educational) leader is capable of recognizing emotions in both himself and others. To properly manage, one must be able to interpret emotions. Thus, an effective educational leader should be able to acquire the confidence and loyalty of others, thereby increasing the organization's efficiency and effectiveness. Neuroscientists are reinventing leadership in the twenty-first century by imbuing the neurological foundation and neural basis of leadership effectiveness with new meaning for leading oneself, others, and an organization renowned for its threefold emphasis on effectiveness [4, 5].

According to neuroleadership practitioners, understanding the neurological underpinnings of leadership success requires grasping the neuroscience of social behavior for engagement, motivation, and peak performance. In addition, neuro-leadership abilities are required of 21st-century leaders to develop connections, manage emotions, make choices, and encourage people to accomplish corporate goals to meet the challenges of reducing achievement gaps and adapting to changing populations [6, 7]. Nonetheless, several contradictory studies address the critical nature of incorporating neuroscience into educational leadership and contribute to its increased effectiveness [8, 9]. The scientific community appears to be skeptical. According to Lindebaum & Raftopoulou (2017) [8], recorded knowledge of brain patterns has little practical effect on existing social behaviors. Neuroimaging research has shown comparable results, indicating that integrating neuroscience discoveries into educational leadership would not modify management paradigms, i.e., [9]. On the other hand, neuroscience has posed a challenge to organizational management and given new meaning to organizational and leadership performance [10]. Neuroscientific data can be critical in defining educational leadership in terms of cognition, specifically in terms of the decision-making, problem-solving, emotional regulation, and personal qualities of academic leaders.

Over the past decades, the scientific community in the neuroscience and education sectors has emphasized the biological parameters involved in leadership combined with the personality traits of the leader that determine decision making. This scientific interest has given impetus to the development of neuro-leadership studies. Neuroscience, the subject of neuroleadership, is a branch of study that studies the interplay of neurons that underpin human behavior and its consequences. Neuroleadership, defined as the ability to link brain regions with leadership actions, attempts to bolster the leadership sector via the use of neuroscience research. Neuroleaders lead their organizations by developing a management plan based on brain research. Neuroscience provides significant growth opportunities for leaders and managers through studying biological and neurochemical processes in the brain for instance decision-making and emotional regulation. As a result, academics may develop better educated theories and leadership styles by delving into the neural underpinnings of behavior.

The purpose of this study is to examine the value of integrating neuroscience into education, particularly in the area of decision making and problem solving, by stressing executive function characteristics such as cognitive flexibility, emotional regulation, and the visual system of mirror neurons. Those are critical components in the performance of rational educational leadership, if feasible.

2- Literature Review

2-1- Neuroleadership in Education – Brain Facts and Theory Implications

The frontal cortex is the apex of a brain area hierarchy that integrates external and internal factors in order to reflect, arrange chronologically, and execute complicated mental and behavioral responses to environmental obstacles, such as those related with leadership. The frontal cortex is connected to almost all other cortices, subcortical areas, and brain stem nuclei, allowing it to access and control a wide variety of cognitive resources. Additionally, it has been demonstrated that a substructure known as the ventromedial prefrontal cortex collaborates with limbic areas as an emotion regulator to facilitate efficient mental functioning in the pragmatics of social life, including self-regulation of agency and goal-directed activity, social self-awareness, decision-making, and moral behavior [11-13]. Additionally, frontal lobe participation has been shown in investigations of episodic memory (for example, hemisphere encoding and retrieval asymmetry) [13, 14]. Semantic memory is associated with the left prefrontal cortex [15]. Thus, encoding is required for both episodic and semantic memory. While semantic memories might begin in a personal context, they can progressively shift from episodic to semantic memory as their sensitivity and identification with individual events diminish. Thus, self-awareness may grow more generic over time, enabling it to be applied to novel circumstances. As a result, it's unsurprising that both depend on frontal lobe functions. Thus, the frontal lobes include a large number of the neurological abilities necessary for leadership [13].

The term "neuroleadership" evolved out of a desire to learn more about how humans may improve overall leadership abilities and effectiveness. It arose when neuroscientists were able to watch live human brains (through functional Magnetic Resonance Imaging (fMRI) scanners, for example) and gain new insights into how the human brain works.

Neuroleadership is an area of study that focuses on the neurological underpinnings of leadership and management techniques. It synthesizes results from various disciplines within neuroscience, including social cognitive and affective neuroscience, cognitive neuroscience, integrative neuroscience, neurobiology, and others. It is believed that establishing a science of leadership that incorporates the mind's and brain's physiology would become more accessible to leaders interested in learning and improving themselves and others. Additionally, it converts the soft skills associated with professional growth into practical talents by using scientific evidence. Neuroleadership is divided into four subfields of research. These include decision-making and problem-solving, emotional control, collaboration and influence with others and change-facilitation. Each one of these sub-dimensions, has the potential to integrate a neuroscience perspective with established models that assist us in resolving common problems. Due to the brain's neuroplasticity, the fusion of leadership and neuroscience opens new avenues for leaders to learn how to adapt and alter their leadership methods and behaviors to become more successful practitioners [1, 16].

Furthermore, neuroleadership can boost effective educational leadership due to the fact that effectiveness in educational leadership and in the field of human resource management is established on the capacity to control one's emotions [17]. A leader's emotional intelligence defines their ability to influence behavior and contribute to an individual's personal growth by mobilizing, motivating, and stimulating their mental talents. An emotionally savvy leader may inspire trust and loyalty in his subordinates and push them to work harder to accomplish a mutually agreed objective. Leaders' emotional intelligence is critical to their capacity to encourage people to accomplish corporate goals. Emotional intelligence and leadership behavior [18], particularly in the decision-making process, are inextricably linked. With theoretical perspectives on transformational leadership and its link to emotional intelligence, empirical research has established a favorable correlation between these notions. A survey performed by the global Johnson & Johnson Consumer Care and Personal Care Group discovered that executives with the highest job performance have considerably greater emotional intelligence than other executives.

Additionally, research evaluating the success characteristics of a broad sample of Latin American, Japanese, and German CEOs is intriguing [19]. Successful and unsuccessful managers were shown to have distinct profiles in three critical areas: seniority and advanced experience, cognitive intelligence, and emotional intelligence. Typically, unsuccessful managers have a much greater level of cognitive competence and professional experience than successful managers. Additionally, he has a poor level of emotional intelligence. On the contrary, effective managers have a much greater degree of emotional intelligence in addition to a sufficient level of cognitive intelligence and job experience.

Several studies [17] have examined leaders' capacity to identify others' feelings, how leaders may use emotions to monitor their followers in working groups, and how leaders can utilize emotions to build leadership skills. These qualities and skills are critical in leadership processes because they influence how followers view their leaders. As a result, the relationship between transformative leaders and their followers develops into a highly emotional one. Transformational leaders demonstrate various non-verbal emotional qualities (for instance, their perspective on others and their verbal comfort) that make them fascinating and charismatic leaders. In addition, influential, transformative leaders must have the intuitive ability to empathize with people and offer counsel when necessary [20].

In the realm of education, transformational leadership is instrumental. Education is a critical social framework for the future of society. Schools in the twenty-first century must adapt successfully to a rapidly changing world. Changes occurring in the global environment consider the teacher-position leader vital to any transformation's success [21-23]. Teachers, as change agents, must possess the essential skills and capacities to teach tomorrow's citizens, successfully building their intellectual, emotional, and social capital at all levels of school [24].

Emotionally intelligent teachers appear to be more successful leaders because they can recognize and regulate their own and pupils' emotions, such as anger or irritation, and adapt their conduct to varied situations. Additionally, given the evidence that increased stress and psychological exhaustion contribute to teachers' intention to resign from effective knowledge management, research into the influence of emotional teachers' intelligence appears to be particularly promising for success.

3- Research Design and Methods

The current study's systematic review intends to combine studies including the following scientific fields: Neuroscience, Cognition, Leadership, Decision-making, and Emotional regulation, in the field of education and learning process—the publications included span the last decade, more precisely from 2010 to 2021.The research methodology is described in the following figure (Figure 1).
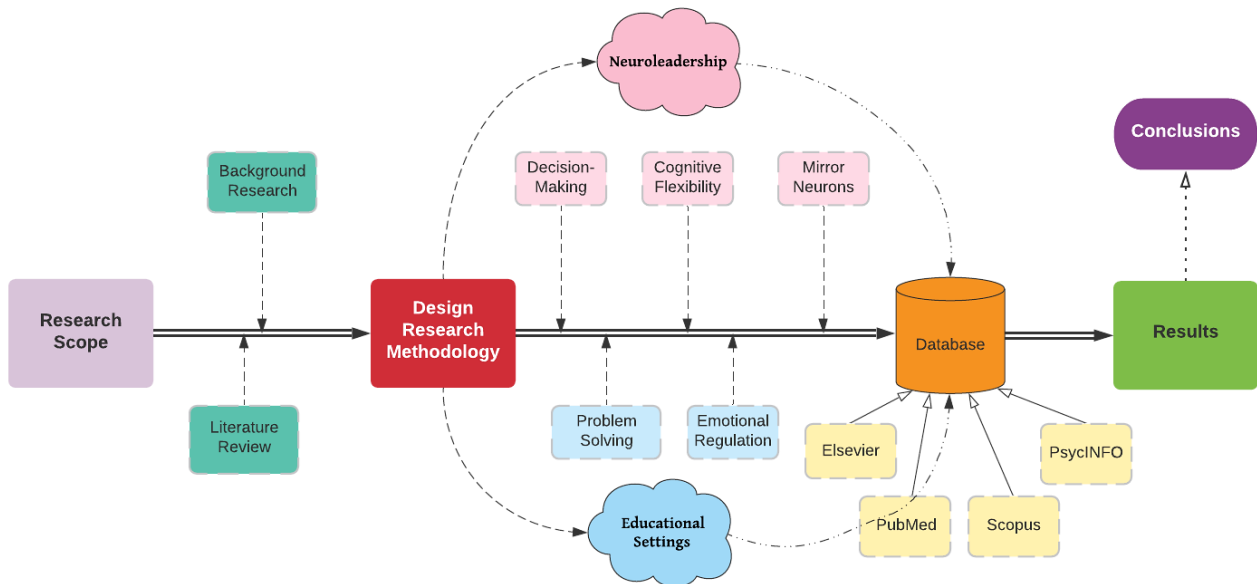
Figure 1. Research Methodology Flowchart

The methodology adopted in the current study is systematic review. Firstly, research articles after detailed searching integrated in the study from databases of Scopus, PubMed, Elsevier and PsycINFO. Keywords that used the term of neuroleadership, education in conjunction with the four subfiends that have been described in research: These include - decision-making and problem-solving, emotional control, collaboration and influence with others and change-facilitation. Additionally, other parameters, such as personality and cognitive flexibility, were integrated to combine neuroleadership research findings for the purpose of sculpting a neuroleader personal profile for transformational leadership in education (Figure 1). All of the studies were further divided into groups based on their experimental models, which may be qualitative or quantitative, as well as their inclusion criteria, which included the following:

- Year of publication from 2010- till today (N=96);

- Primary search terms referred to the theoretical or methodological approaches in the context of neuroleadership, cognitive neuroscience and education in conjunction with the sub-dimensions of neuroleadership: decision-making, emotional control, collaboration with others, change-facilitation and in addition with specific parameters of decision-making, cognitive flexibility (dimension that is considered as crucial for an educational leader and the idiosyncrasy as defined by the notion of mirror neurons so as to describe a complete theoretical framework for neuroleadership);

- Method of study: Qualitative data;

- Study population: Employees in Educational and Management settings.

In this study, the systematic literature review method was adopted. A systematic literature review is a type of scientific investigation in which the studies conducted on a particular subject are scanned in detail, and the findings are synthesized after the criteria of exclusion and inclusion in the collection of related studies. Basic topics, research questions, and goals are the starting point for a systematic literature review. Then, the related publications are defined; the selection, evaluation, and interpretation of the studies are based on a conceptual perspective; the sources of the data used and the way they are analyzed and synthesized are clarified, and finally, the findings, limitations, and inferences are discussed. All literature reviews are carried out within a specific stage and steps.

After initial judgments had been taken prior to this evaluation, the first phase in the data collection procedure was to determine the keywords. The following keywords were employed specifically: Leadership, Education, Cognitive Parameters, and Neuroscience and other combined parameters with terms like neuroleadership, neuroeducation but also by searching for terms related to the part of decision making (key parameter in leadership), such as cognitive flexibility, emotional regulation.

Following that, the studies were indexed in the most prestigious and widely recognized research databases, including Scopus, PubMed, Elsevier, and PsycINFO. A search revealed a total of 96 (N=96) searches based on keyword combinations. The title of the article and a summary of each one relating to the predefined keywords served as the inclusion criteria for screening the surveys in the second step (Step=2). This stage led to the formation of sixty-four (N=64) articles that met the aforementioned inclusion criteria.

In step three (Step=3), articles whose entire text was inaccessible or hard to find were excluded (N=19). Additionally, they were excluded due to linguistic constraints (N=5); specifically, related works with content authored in a language other than English were excluded. This screening considered the following criteria: studies should be written in English, published between 2010 and 2020, and have practical consequences for neuroleadership research or conceptual talks. There were a total of forty works that matched the criteria mentioned above (N=40). Seven (N=7) research papers were excluded from step four (Step=4) due to a lack of research data. These studies made no direct connections between neuroleadership and outcomes and were therefore excluded from the research group denoted by the flowchart's "Data Quality Score." The study's major themes were established as a result of the papers evaluated. Neuroleadership implications for educational leaders (school leaders and instructors) in terms of decision-making, emotional regulation, and problem-solving were included as themes if they were also supported by other analyzed studies (Figure 2).

Figure 2. **Systematic Review Flowchart**

4- Results and Discussion

4-1- Neuroleadership - Decision-Making and Problem Solving

Neuroleadership is founded on two fundamental concepts: decision-making and issue resolution (problem-solving). Adaptability is a behavioral component associated with effective neuroleadership in the education and management of other organizations. It is a cognitive dimension that encompasses innovative problem-solving in response to changing conditions, uncertain or unpredictable scenarios. Adaptation requires a high level of self-awareness and the capacity to steer critical decisions in leadership and, more significantly, educational contexts. A leader should recognize changes in the work environment, interpret them to formulate goals, and forecast future occurrences that need a high degree of adaptation or change. Likewise, Paulhus & Martin (1988) [25] as is cited by Hannah et al. (2013) [13], observed that a diverse repertoire of information, actions, and tactics is a feature shared by several conceptualizations of a leader's adaptability [26]. The learning that underpins such flexibility in leaders includes both task and personal development. The latter improves one's awareness of oneself, identity, capacities, and other task-related characteristics. Thus, the self-acts as a link between the actions of leaders and the underlying processes that underpin adaptive performance. Educational leaders face task demands; identity structures are primed to initiate self-regulation functions at five hierarchical levels: (a) perception, (b) consciousness, (c) goal emergence, (d) affect systems, and (e) at the top of the hierarchy, these lower structures aggregate to activate a tailored working self-concept. Thus, leaders who have the greatest access to a breadth of relevant knowledge and skills, as well as self-regulatory structures, in order to comprehend problems and develop tailored working self-concepts, should be better equipped to engage the self in deliberations and guide the process toward their goals and priorities.

According to an emerging body of neuroscience research, the neural pattern observed at rest represents the brain's underlying functional connections and an individual's inherent and constant brain function or aptitude [27]. Indeed, Cacioppo et al. (2003) [28] argued that the brain is not inert during rest but performs various potentially important neuronal activities, including memory consolidation and learning [13]. Fox & Raichle (2007) [19] discovered that patterns of brain activity during rest correlate to patterns of task involvement. Waldman et al. (2011) [29] have suggested that the brain's resting state may indicate genuine leadership skills. At this stage, integrating neuroscience into the explanation of leadership styles can provide relevant concepts for developing a better knowledge of the brain activity of leaders, particularly educational leaders. And therefore, to shed light on the fundamentals of effective leadership. The brain basis for a leader's self-complexity may also provide insight on leadership development. An increasing field of social neuroscience research is shedding light on the functions and processes of many brain regions. Additionally, growth in this area may be tracked over time using EEG, fMRI, and other techniques. Butler et al. (2016) [30] found that more competent leaders had reduced alpha coherence in the prefrontal cortex, which is largely responsible for executive processes such as self-regulation [13, 30]. Thus, it is possible to submit leaders to activities designed to enhance their metacognitive capacity and then evaluate changes in prefrontal brain activity over time as they advance toward a normative index. Undoubtedly, the neurocognitive revolution in educational leadership studies has shifted focus to leaders' thinking processes in order to better understand their actions and effectiveness.

4-2- Neuroleadership - Emotional Regulation

Emotional regulation is another perspective that has been studied in neuro leadership research. Neuroscientific methods can explain a further understanding of emotions and unconscious processes that interfere with them and lead human behavior. Communication between educational leaders and colleagues or, between instructor and learner is a essential part of the educational process and is characteristic in learning environments. Educational leadership is highly interested in communication processes expertise since this process exists at all levels of management, beginning with communication between leaders and employees and ending with peer communication between colleagues. Communication is the primary tool for sharing practices inside an organization, and executives have long recognized communication as critical to their success. For an extended period, academics and psychologists asserted that a competent leader's role was to foster a specific "social climate" within the group, which impacted the members' moods and performance. Thus, a transformative leader maintains a healthy balance of production and group member happiness. Additionally, we know that leaders with a higher level of emotional intelligence can sympathize with employees' emotions and exhibit more emotionally appropriate interactions and behaviors [17]. Empathy, or the capacity to empathize with the feelings of others, refers to both cognitive and emotional processes that enable us to represent other people's mental and affective processes cognitively and to generate an actual reaction consistent with their actions. The literature demonstrates a strong correlation between emotional empathy and the capacity to identify facial expressions. Observing their facial expressions may deduce their emotional states [31]. Educational leadership aims to explain a leader's behavior structure using neuropsychology and cognitive neuroscience insights. These advancements enable the examination of the brain systems behind emotions and communication and the personal profile and behavioral style of an educational leader or instructor.

May-Vollmar (2017) [32] conducted a study on emotional intelligence and school leader performance and discovered that emotional intelligence is a significant predictor of an individual's ability to execute successful leadership practices. Along with school, leaders can control their emotions; they must recognize their position in facilitating change. Leaders who demonstrate self-awareness and self-control, for example, can recognize when an encounter is causing them to feel irritated and will be able to manage their emotional response throughout the contact. For instance, a leader may have had extensive training in the art of inspiring others to share a vision. However, the leader's dissatisfaction might obstruct the leader from adequately executing the leadership practice. The leader's capacity to comprehend and recognize emotional triggers resulting from developing self-awareness of their own emotions and those of others enables them to boost motivation and engagement levels by strategically considering how to minimize workplace stress and elicitation of negative emotions.

Saxe (2011) [33] conducted a study on school leaders' emotional and social intelligence and discovered that effective leaders cultivate strong relationships:

- By empathizing with people and being just;

- By ensuring autonomy and predictability during the transition process;

- By elevating people' standing via personalized assistance and partnership.

Saxe (2011) [33] provided the following research findings. In the five-brain model indicated that the limbic system is composed of the amygdala, hippocampus, fornix, cingulate cortex, septum, mammillary bodies, and striatum. According to Rock and Cox (2013) [34], when an individual compares his or her position to that of another, the cingulate cortex (dorsal anterior cingulate cortex) is engaged, the same brain area that processes pain. Additionally, as status improves and pleasure is received during social processing, the reward brain circuitry in the striatum is engaged. As a result, Rock and Cox (2013) [34] assert that "Information validating one's status can activate the reward brain circuitry. While a person receives a social benefit, namely when believing that he or she was establishing a positive reputation with others, activity in the striatum [is stimulated]." When individuals feel important to their colleagues and school administrators, their status improves as a result of the reward brain circuitry being triggered. By identifying changes to elevate the status of individuals who work in a school environment, influential school leaders can reduce the danger circuitry of the brain and boost the reward circuitry. In a school context, opportunities to elevate others' status include open invitations to serve on committees, encouragement to develop supervisory skills, solicitation of additional talents and experience, and customizing professional development to ensure ongoing progress. Educational administrators in the twenty-first century may be, wish to foster healthy, balanced school cultures. In this situation, skills in teaching and learning, strategic management, and social, emotional, and cultural awareness of both kids and adults are required. To promote change and impact individual behaviors and cooperation, school leaders must understand how to nurture and grow everyone's potential, leveraging school leader intelligence to improve clarity and foster autonomy aligned with organizational success. "Leadership success is contingent upon a leader's capacity to solve a complicated social problem, such as the coordination of ideas and behaviors within social groupings".

4-3- Neuroleadership – Mirror Neurons

"Social intelligence is a kind of emotional intelligence that focuses on interpersonal relationships. Daniel Goleman's approach consists of four domains: self-awareness, emotional self-management, empathy, social awareness, and social skills – or relationship management. Furthermore, the second two of those components, empathy and social ability, comprise social intelligence". The neuroleadership idea is based on the mirror neurons effect and how great leaders can connect with their followers through rapport-building in order to develop highly focused and effective teams that are just as fascinated with the goal as their leader is. Social neuroscience, a subfield of neuroleadership, argues that a leader must be an expert in his area and possess social intelligence.

A true leader demonstrates empathy for his team, instilling a strong belief in the vision. Thus, the neuroleadership idea encompasses both the aspiration to succeed and the united objective. Employees search for clues from supervisors and instinctively emulate their conduct. This demonstrates the critical nature of having a positive perspective and setting an example of desired conduct for leaders. Additionally, leaders may have a better knowledge of others by first gaining a better awareness of themselves.

Thus, mirror neurons offer a unique chance for humans, particularly those who exert educational leadership, to put themselves in the footsteps of another and experience the world from another (physical and mental) perspective, comprehending its intentions, actions, and feelings. This tendency is in conjunction with the executive parameter that is referred to as cognitive flexibility (and will be analyzed later). It enables the individual to learn from others and so alter its conduct as necessary (switching). Mirror neurons are the neurobiological mechanism underlying the most humanistic, if not the most compassionate, element of humanity [35]. Their role is to provide the individual with the required tools for social interaction. It supports the development of interpersonal relationships in a professional or, more precisely, educational setting. Furthermore, this is the same human behavior that robotics has been attempting to replicate for a

significant period [36]. The emergence of electronic computing systems based on distributed and parallel computing was a major force of innovation in robotics and artificial intelligence. This method is partially inspired by the idea of human intelligence as the management of symbolic representations and the flow of information at hierarchical and sequential levels of processing in a convergent and divergent way [37]. Artificial neural networks, deep learning, and machine learning are all terms that refer to systems that replicate some human cognitive abilities required for leadership exercise, such as logical thought, learning, pattern identification, decision making, and problem-solving. However, the novelty of technological advancements that replicate the function of mirror neurons is that they extend their function in the realm of emotions to what is known as affective computing. All of the above converges towards establishing an innovative digital leadership system that incorporates artificial intelligence and neural networks.

4-4- Neuroleadership and Cognitive Flexibility – A Reborn Leader's Promising Field

The executive functions of the brain are beneficial cognitive parameters for an organizational leader. Cognitive flexibility is one of these cognitive parameters of executive functions. Cognitive flexibility refers to our brain's capacity to adjust our behavior and thought processes to the novel, alternate, or unexpected circumstances. Cognitive flexibility is critical for learning and problem-solving in complicated situations. It enables us to choose the approach that must be followed to adapt to the various conditions we experience. By contrast, cognitive rigidity refers to the difficulty of modifying habits and ways of thinking when they are ineffective or unable to accomplish the initial objectives. Cognitive flexibility is a competitive advantage for managers and leaders seeking to maximize their potential. In psychology, the term "flexibility" refers to adapting a skill to new situations unrelated to the ones used to train. Thus, a high degree of flexibility should enable an individual to swiftly move from one processing method or style to another, maximizing the advantages and avoiding the disadvantages of each. Cognitive flexibility has been identified as a significant predictor of incredibly complicated and unstructured. It is described broadly as "the capacity to adjust behavior to changing circumstances."

For many years, neuroscientists and psychologists believed that a fixed and predominantly static brain constrained adults' capacity for change. On the other hand, it was believed that children's brains were malleable, continuously changing learning machines capable of absorbing knowledge and randomly rewiring themselves.

To a large extent, it was believed that the differences between adults and children were due to how human brains developed. Around 100 billion neurons are born in the human brain. As people interact with and interpret their environment, connections between these neurons grow. By the time a child reaches the age of two, they have made around 1000 trillion connections. These connections continue to build throughout childhood, assisting the child's growth and learning. The brain undergoes a period of consolidation and considerable neuronal pruning during adolescence. Numerous neurons in the human brain that are seldom utilized die, leading in a loss of around half of all connections, or 500 trillion.

Adult brains are extraordinarily adaptable, and individuals may rewire their brains to accomplish astonishing achievements with the correct approach, patience, and effort. In 1992, for example, Dr Jeffrey Schwartz taught persons with Obsessive Compulsive Disorder (OCD) how to adjust their perceptions of and responses to their disorder's symptoms. (e.g., reclassifying obsessions and compulsions as false alarms or misleading information, attributing these symptoms to hyperactivity in specific brain circuits, devaluing unwanted thoughts as unimportant or unwanted, and redirecting their attention away from their symptoms and toward a specific, desired, and constructive behavior).

After ten weeks of practice and hard effort, Schwartz's patients reported significant improvement in their symptoms and a sense of control over their sickness - a remarkable reversal for individuals who had previously felt completely enslaved by their symptoms. Perhaps more astonishing, Schwartz noticed a difference in the way these people' brains physically functioned over the same ten-week period. Their perspectives of OCD and the accompanying brain processes appeared to have evolved as a result of their frequent, persistent, and purposeful application of will and attention.

Similarly, Arrowsmith-Young (2012) devised a set of cognitive exercises in the 1970's to aid her in overcoming a crippling mental block.' Barbara possesses a near-perfect memory but is unable to comprehend the meaning of symbols. For example, she was unable to comprehend what a clock's hands represented or how to interpret this representation in order to determine the time; she could not distinguish between 'the boy chases the dog' and 'the dog chases the boy'; she read and wrote from right to left; and she frequently swapped letters and numbers. After getting upset with her circumstances and being inspired by the work of neuroscientists Luria and Rozenweig, she created a series of cognitive exercises (flashcards with clock faces on them). She exercised for eight hours a day, almost to exhaustion [38].

Additional neuroplastic treatments have been developed to address function loss associated with clinical themes for instance stroke, depression, addiction, and other learning issues, as well as certain types of blindness and deafness. Similarly, research continues to gather evidence that personality and intellectual characteristics are malleable and may be influenced by our environment and experiences.

This research demonstrates that humans are far more adaptable than previously assumed. With enough effort and practice, leaders or educational leaders and also staff's behaviors could be altered and adapted to new circumstances. Notably, these changes do not occur automatically. Instead, they need repeated acts of will and self-discipline. This is consistent with Angela Duckworth's study, which indicates that grit - or enthusiasm and persistence - rather than talent, aptitude, or competence - is the key to success. Thus, educational leaders appear to be less restricted by capacity, aptitude, and ability. They are more restricted in their effort and attention allocation judgments. In a frenetically busy culture and replete with distractions, neuroplasticity provides opportunities for development and achievement.

The findings of this study can be integrated with the notion of neuroscience in education on the one hand, and with the concept of neuroscience and its contribution to management in terms of decision making and emotion and behavior management in an educational setting on the other. Neuro-leadership is a critical factor in clarifying decision-making processes. Increasing research on the learning process in relation to the biological parameters and personality characteristics of educational leaders has resulted in data-driven solutions for educational leadership that improve its effectiveness in facilitating learning, teaching, and behavior management processes. Applying neuroscience research to education offers the potential to improve students' knowledge, interpersonal skills, motivation, and decision-making processes. Further experimental research can be employed to bolster the study's findings in this regard. New discoveries can assist schools in incorporating neuroscience-based teaching and leadership practices. School principals who are aware of these viewpoints can help improve their students' grades. As a result, authorities should place a premium on training educational leaders who grasp behavioral basics. With this information, schools may capitalize on neuroscience's opportunities, find the most successful educational processes, and comprehend biological and environmental aspects that influence the psychological condition of the populations they serve in order to optimize academic operations. Neuroscience in education should not be viewed just as a means of implementing pertinent findings in educational management. By teaching or informing pupils about the way the brain learns, they may adopt more effective learning stages. These studies demonstrate that boosting students', educators', and students' knowledge of how the brain develops and learns can greatly expedite learning or development. The acquisition of neuroscience information by teachers has an effect on their pedagogical understanding and teaching abilities [39, 40]. One reason neuroscience research is critical in education is to ascertain how a human being is impacted by his or her non-social, biological aspect. Leadership behaviors are defined by the leaders' own attitudes and the environment in which they operate [41]. This demonstrates that, in terms of educational leadership, an individual may be an excellent leader with appropriate training and support from surroundings. However, the quality of a person's leadership is influenced by his genetic, hormonal, physical, and mental growth and maturity.

Because leadership development is interconnected with a person's disposition, genetics, and physical development, neuroscience sheds light on this mostly opaque issue. Neuroscience-based knowledge can help advance both theory and practice of leadership [42]. However, the fact that school decision-making processes rely excessively on data and that all operations are assessed in light of data promotes instrumentation [41]. Additionally, school principals must recognize that individuals possess emotions in addition to hereditary features and that individuals exhibit inconsistency. As a result, judgments should be made using evidence-based procedures while simultaneously considering the human factor. Additionally, neuroscience research makes several recommendations for teacher and leader development programs. Leadership and teacher education programs should place a premium on persons who are capable of managing stressful situations, possess a biological understanding of stress, and possess knowledge of skills such as collaboration, acceptance of change, and active research [43, 44]. Top-notch training methods may entail supervisors that are emotionally stable, cognizant of the factors that influence people's decision-making processes, and knowledgeable in their domains. According to Pope (2019) [5], influential school leaders foster relationships via empathy, communication, and cooperation. When leaders foster a feeling of community among teachers, they generate a higher level of trust and empathy for their colleagues. Neuroleadership emphasizes the need of understanding both the management and physical components of leadership, as well as the chemical development of the brain and the needs of the people a leader leads [44].

The study's fundamental implications for educational leaders are as follows: Given the neuroscience studies on multitasking, school leaders as neuroleaders are supposed to avoid giving numerous tasks. They efficiently control their emotions, are aware of the biological and sociocultural consequences of sleep, stress, motivation, reward, and threat, and then respond appropriately. Institutional leaders who understand the biological underpinnings of behavior may use this knowledge to transform their schools' projects. Neuroleaders may impart information about how the human brain works to their students, so increasing their awareness. Policymakers should continue to analyze these fundamental results and work to provide a diverse variety of developmental programs in educational settings that are all based on neuroscience findings. For organizational effectiveness, 21st-century leaders must comprehend the underlying architecture of the brain, human attitudes, and behavior. This study aimed to assist instructional leaders in understanding the neurological foundation for employee engagement, motivation, and productivity. Building reliable connections, synchronizing the purpose and vision into clear, concrete steps, and providing clarity and assurance for autonomy and cooperation are all skills that a skilled school leader may use to link individuals across an organization [44]. The current study's systematic review summarized the findings regarding the importance of integrating neuroscience into educational

environments and, more specifically, its contribution to critical areas of decision making and emotional management through an analysis of the results of cognitive studies on staff functions and, more specifically, cognitive flexibility. However, the current study has certain drawbacks. One of the limitations of this research is that in the current review, data from neuroimaging studies that have been conducted were not utilized. The integration of neuroimaging studies elucidates the benefits of neuroleadership in an educational context in greater detail and precision. However, it is necessary to highlight some ethical concerns about the integration of neuroscience into education, specifically those surrounding the preparation of brain research projects in an educational setting, which will be discussed in greater detail in a future review paper on the ethics of neuroscience in neuroeducation.

5- Conclusions

Neuroleadership is one of the most widely discussed topics in contemporary science. The findings of this study enable the author to offer an integrated and improved strategy for work engagement treatments based on recent neuroleadership discoveries. Recognizing the need for more study, we have highlighted other developing research issues and themes proposed by the authors of the examined publications.

To sum up, all social interaction and thinking starts in the brain. According to brain experts, social pain is processed in the same region of the brain as physical pain. Thus, interpersonal attunement is a crucial trait of transformative leadership. There are four dimensions of neuroleadership that address transformative leadership abilities, including social and emotional intelligence, communication, and empathy. Teachers think a principal's social and emotional abilities impact leadership effectiveness. For example, a successful school leader may establish connections and influence people by controlling their perceptions of others by being fair and equal. Thus, school leadership development needs profound self-reflection and social awareness to manage negative sentiments in the workplace. Schools need leadership intelligence to make decisions to lead effectively in the 21st century; educators must have social and emotional intelligence. For high levels of student performance and high-quality instructional practice, school leaders must simultaneously control emotions, cooperate with others, promote change, and encourage and engage employees to adhere to the organization's vision and goal.

The brain is a social organ. Successful school leaders must set high expectations in order to reduce the threat of a reaction. To develop a reflective culture for enhancing teaching and learning, successful school leaders must elevate employees who demonstrate talent and strategic management abilities while promoting autonomy. The intelligent school leader works with others to achieve organizational goals to encourage, engage, and inspire them. Lastly, the school leader uses social and emotional intelligence to get people to work together for the success of the whole organization.

5-1- Future Research

Neuroscience is one of the most widely discussed subjects in contemporary science. The findings of this study enable the author to offer a comprehensive and improved strategy for work-dedication therapies based on recent neuroscience breakthroughs. In recent years, neuroscience and leadership have formed a debate within organizations and businesses. By investigating the structure and function of the brain, neuroscientific research provides scientifically-proven knowledge that informs the execution of leadership. This partnership's current objective is to address the following questions: How should leadership be exercised to a) raise and sustain the effectiveness of executives, b) increase and maintain productivity, and c) activate and positively engage people in the pursuit of the goals of an educational institution or business? The brain is the origin of all social interaction and thought. Social pain, according to brain specialists, is processed in the same region of the brain as physical pain. Consequently, interpersonal coordination is an essential characteristic of transformational leadership. By adjusting to the changing academic landscape of digital transformation, leaders must build and improve a combination of digital and soft skills, particularly practical communication abilities, in a new context. Maintaining coherence between geographically dispersed nodes requires initiative and the ability to adapt to diverse and complicated challenges and functions.

6- Declarations

6-1- Author Contributions

E.G., C.H. and H.A. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6-3- Funding

6-4- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

7- References

[1] Psychogios, A., & Dimitriadis, N. (2021). Brain-Adjusted Relational Leadership: A Social-Constructed Consciousness Approach to Leader-Follower Interaction. Frontiers in Psychology, 12. doi:10.3389/fpsyg.2021.672217.

[2] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021). Associations between traditional and digital leadership in academic environment: During the COVID-19 pandemic. Emerging Science Journal, 5(4), 405–428. doi:10.28991/esj-2021-01286.

[3] Mayer, J. D., Salovey, P., & Caruso, D. (2000). Models of Emotional Intelligence. Handbook of Intelligence, 396–420, Cambridge University Press, Cambridge, United Kingdom. doi:10.1017/cbo9780511807947.019.

[4] Spawr, A. L. (2011). Drive: the surprising truth about what motivates us, Pink, D.H. (2009). New York, NY (pp. 1-242). Journal of Community & Applied Social Psychology, 22(1), 92–94. doi:10.1002/casp.1085.

[5] Pope, S. N. (2019). A systematic literature review of school leadership intelligences for the development of neuro-educational leadership. Ph.D. Thesis, University of New England, Armidale, Australia.

[6] Leithwood, K. (2007). What We Know About Educational Leadership. Studies in Educational Leadership, Springer, Dordekht, Netherlands, 41–66. doi:10.1007/978-1-4020-6022-9_4.

[7] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2019). Transition from educational leadership to e-leadership: A data analysis report from TEI of western Greece. International Journal of Learning, Teaching and Educational Research, 18(9), 238–255. doi:10.26803/ijlter.18.9.13.

[8] Lindebaum, D., & Raftopoulou, E. (2017). What Would John Stuart Mill Say? A Utilitarian Perspective on Contemporary Neuroscience Debates in Leadership. Journal of Business Ethics, 144(4), 813–822. doi:10.1007/s10551-014-2247-z.

[9] Ringleb, A. H., & Rock, D. (2008). The emerging field of NeuroLeadership. NeuroLeadership Journal, 1(1), 3-19..

[10] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021). Transformational leadership and digital skills in higher education institutes: During the covid-19 pandemic. Emerging Science Journal, 5(1), 1–15. doi:10.28991/esj-2021-01252.

[11] Gkintoni, E., Pallis, E. G., Bitsios, P., & Giakoumaki, S. G. (2017). Neurocognitive performance, psychopathology and social functioning in individuals at high risk for schizophrenia or psychotic bipolar disorder. Journal of Affective Disorders, 208, 512–520. doi:10.1016/j.jad.2016.10.032.

[12] Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L. B., Parvizi, J., & Hichwa, R. D. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. Nature Neuroscience, 3(10), 1049–1056. doi:10.1038/79871.

[13] Hannah, S. T., Balthazard, P. A., Waldman, D. A., Jennings, P. L., & Thatcher, R. W. (2013). The psychological and neurological bases of leader self-complexity and effects on adaptive decision-making. Journal of Applied Psychology, 98(3), 393–411. doi:10.1037/a0032257.

[14] Habib, R., Nyberg, L., & Tulving, E. (2003). Hemispheric asymmetries of memory: The HERA model revisited. Trends in Cognitive Sciences, 7(6), 241–245. doi:10.1016/S1364-6613(03)00110-4.

[15] Gkintoni, E., Meintani, P. M., & Dimakos, I. (2021). Neurocognitive and Emotional Parameters in Learning and Educational Process. ICERI2021 Proceedings. doi:10.21125/iceri.2021.0659.

[16] Antonopoulou, H., Katsibelis, A., & Halkiopoulos, C. (2021). Cognitive Parameters Detection via Gamification in Online Primary Education during Covid-19. INTED2021 Proceedings. doi:10.21125/inted.2021.2007.

[17] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. (2021). Digital leader and transformational leadership in higher education. INTED2021 Proceedings. doi:10.21125/inted.2021.2005.

[18] Gkintoni, E., Koutsopoulou, I., Antonopoulou, H., & Christopoulos, P. (2021). Consequences of the covid-19 pandemic on Greek students' mental health: quality of life and trauma stressful events correlation. ICERI2021 Proceedings. doi:10.21125/iceri.2021.0663.

[19] Fox, M. D., & Raichle, M. E. (2007). Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. Nature Reviews Neuroscience, 8(9), 700–711. doi:10.1038/nrn2201.

[20] Hyseni Duraku, Z., & Hoxha, L. (2021). Impact of Transformational and Transactional Attributes of School Principal Leadership on Teachers' Motivation for Work. Frontiers in Education, 6. doi:10.3389/feduc.2021.659919.

[21] Bezzina, C. (2000). Educational leadership for twenty-first century Malta: Breaking the bonds of dependency. International Journal of Educational Management, 14(7), 299–307. doi:10.1108/09513540010378950.

[22] Davies, B. (2002). Rethinking schools and school leadership for the twenty-first century: Changes and challenges. International Journal of Educational Management, 16(4), 196–206. doi:10.1108/09513540210432182.

[23] Wong, E. O. W. (2003). Leadership style for school-based management in Hong Kong. International Journal of Educational Management, 17(6), 243–247. doi:10.1108/09513540310487569.

[24] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2020). Leadership types and digital leadership in higher education: Behavioural data analysis from University of Patras in Greece. International Journal of Learning, Teaching and Educational Research, 19(4), 110–129. doi:10.26803/ijlter.19.4.8.

[25] Paulhus, D. L., & Martin, C. L. (1988). Functional Flexibility: A New Conception of Interpersonal Flexibility. Journal of Personality and Social Psychology, 55(1), 88–101. doi:10.1037/0022-3514.55.1.88.

[26] Klein, H. J., & Fein, E. C. (2005). Goal Propensity: Understanding and Predicting Individual Differences in Motivation. Research in Personnel and Human Resources Management, Emerald Publishing Limited, Bingley, United Kingdom, 215–263. doi:10.1016/s0742-7301(05)24006-9.

[27] Raichle, M. E., & Snyder, A. Z. (2007). A default mode of brain function: A brief history of an evolving idea. NeuroImage, 37(4), 1083–1090. doi:10.1016/j.neuroimage.2007.02.041.

[28] Cacioppo, J. T., Berntson, G. G., Lorig, T. S., Norris, C. J., Rickett, E., & Nusbaum, H. (2003). Just because you're imaging the brain doesn't mean you can stop using your head: a primer and set of first principles. Journal of personality and social psychology, 85(4), 650.. doi:10.1037/0022-3514.85.4.650.

[29] Waldman, D. A., Balthazard, P. A., & Peterson, S. J. (2011). Social cognitive neuroscience and leadership. Leadership Quarterly, 22(6), 1092–1106. doi:10.1016/j.leaqua.2011.09.005.

[30] Butler, M. J. R., O'Broin, H. L. R., Lee, N., & Senior, C. (2016). How Organizational Cognitive Neuroscience Can Deepen Understanding of Managerial Decision-making: A Review of the Recent Literature and Future Directions. International Journal of Management Reviews, 18(4), 542–559. doi:10.1111/ijmr.12071.

[31] Balconi, M., & Venturella, I. (2017). Neuromanagement. What about emotion and communication. Neuropsychological Trends, 21(1), 9–21. doi:10.7358/neur-2017-021-balc.

[32] May-Vollmar, K. (2017). Preparing Tomorrow's Administrators: A Quantitative Correlation Study of the Relationship between Emotional Intelligence and Effective Leadership Practices. PhD Thesis, Elementary Secondary Education, University of La Verne, CA 91750, United States.

[33] Saxe, D. (2011). The relationship between transformational leadership and the emotional and social competence of the school leader. PhD Thesis, School of Education, Loyola University Chicago, Chicago, United States.

[34] Rock, D. & Cox, C. (2012). SCARF in 2012: updating the social neuroscience of collaborating with others. Neuroleadership Journal, (4)4, 1-16.

[35] Becker, W. J., Cropanzano, R., & Sanfey, A. G. (2011). Organizational neuroscience: Taking organizational theory inside the neural black box. Journal of Management, 37(4), 933–961. doi:10.1177/0149206311398955.

[36] Mees, G. W. (2008). The relationship among principal leadership, school culture, and student achievement in Missouri middle schools. Ph.D. Thesis, Educational Leadership and Policy Analysis, University of Missouri-Columbia, Columbia City, United States, doi:10.32469/10355/5540.

[37] Tokuhama-Espinosa, T. (2019). The Learning Sciences Framework in Educational Leadership. Frontiers in Education, 4. doi:10.3389/feduc.2019.00136.

[38] Arrowsmith-Young, B. (2012). The woman who changed her brain: And other inspiring stories of pioneering brain transformation. Simon and Schuster, New York, United States.

[39] Kuhlmann, N., & Kadgien, C. A. (2018). Neuroleadership: Themes and limitations of an emerging interdisciplinary field. Healthcare Management Forum, 31(3), 103–107. doi:10.1177/0840470417747004.

[40] Dubinsky, J. M., Guzey, S. S., Schwartz, M. S., Roehrig, G., MacNabb, C., Schmied, A., Hinesley, V., Hoelscher, M., Michlin, M., Schmitt, L., Ellingson, C., Chang, Z., & Cooper, J. L. (2019). Contributions of Neuroscience Knowledge to Teachers and Their Practice. Neuroscientist, 25(5), 394–407. doi:10.1177/1073858419835447.

[41] Wang, Y. (2019). Pulling at Your Heartstrings: Examining Four Leadership Approaches from the Neuroscience Perspective. Educational Administration Quarterly, 55(2), 328–359. doi:10.1177/0013161X18799471.

[42] Pittman, A. (2020). Leadership Rebooted: Cultivating Trust with the Brain in Mind. Human Service Organizations Management, Leadership and Governance, 44(2), 127–143. doi:10.1080/23303131.2019.1696910.

[43] Schwartz, M. S., Hinesley, V., Chang, Z., & Dubinsky, J. M. (2019). Neuroscience knowledge enriches pedagogical choices. Teaching and Teacher Education, 83, 87–98. doi:10.1016/j.tate.2019.04.002.

[44] Gocen, A. (2021). Neuroleadership: A conceptual analysis and educational implications. International Journal of Education in Mathematics, Science and Technology, 9(1), 63–82. doi:10.46328/ijemst.1237.