EXPLORING THE IMPACT OF NEUROEDUCATION ON UNIVERSITY STUDENTS: APPLICATIONS AND IMPLICATIONS IN LEBANON

استكشاف تأثير التعليم العصبي على طلاب الجامعات: التطبيقات والتداعيات في لبنان

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يتناول هذا المقال تأثير علم الأعصاب التربوي على طلاب الجامعات في لبنان، ويهدف إلى دمج مبادئ علم الأعصاب في الممارسات التعّليميّة لتعزيز نتائج التعلم. يعد علم الأعصاب التربوي مجالًا متعدد التخصصات يجمع بين علم الأعصاب وعلم النّفس والتربية، ويوفر أطرًا ثاقبة لفهم التطور المعرفي، ويساهم في تطوير استراتيجيّات تعليميّة فعالة في التعليم العالي. من خلال دراسة مسار تطور هذا العلم والأسس العصبيّة البيولوجيّة للتعلم والتّطبيقات العمليّة في المناهج والتقنيات التّعليميّة، يناقش المقال التحديات الفريدة التي تواجه النظام التعليمي اللبناني. كما يسلط الضوء على الدّور المهمّ لعلم الأعصاب التربوي في سد الفجوة بين النّظريّة التربويّة والممارسة. ويوصي في النهاية بوضع سياسات لتعزيز كفاءة التعليم في لبنان، مع تأكيد ضرورة معالجة القيود الاقتصادية وتوفير التدريب المهني لضمان التنفيذ الناجح. تسلط هذه الدراسة الضوء على إمكانات علم الأعصاب التربوي في ردم الفجوة بين علم الأعصاب وعلم التربية لتحسين النتائج التعّليميّة.

الكلمات المفتاحيّة: علم الأعصاب التربوي، التعليم العالي، التطور المعرفي، إصلاح التعليم في لبنان، البحث متعدد التخصصات والتداخل المعرفي

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Abstract

This article explores the impact of neuroeducation on university students in Lebanon, aiming to integrate neuroscience principles into educational practices to enhance learning outcomes. Neuroeducation, as an interdisciplinary field that merges neuroscience, psychology, and education, offers insightful frameworks to understand cognitive development and informs effective teaching strategies in higher education. Through examining historical developments, the neurobiological foundations of learning, and practical applications in curricula and instructional techniques, the article addresses the unique challenges faced by the Lebanese education system. It highlights the significant role of neuroeducation in bridging the gap between educational theory and practice. Ultimately recommending policy implications for advancing educational efficacy in Lebanon, successful implementation will require addressing economic constraints and providing professional training. The research highlights the promise of neuroeducation in bridging gaps between neuroscience and pedagogy to improve educational outcomes.

Keywords: Neuroeducation, higher education, cognitive development, Lebanese educational reform, multidisciplinary & Interdisciplinary Research.

1. Introduction to Neuroeducation

Neuroeducation refers to the interaction of neuroscience and education. Education is concerned with the general principles of teaching and learning in relation to the understanding of behaviour and the environment, while neuroscience focuses on understanding the structure and functions of the nervous tissue, especially the brain, and how this relates to behaviour, cognition, and all bodily processes (S.C. Thomas et al., 2019). Neuroeducation, therefore, represents an interdisciplinary overlap between neuroscience and education. In addition, neuroeducation is an emerging interdisciplinary field that integrates principles of neuroscience, psychology, and education to better understand how the brain learns and retains information, and how such knowledge can be applied in an educational context (Kaufmann et al., 2021)(Avery et al.2021)

Educational neuroscience is a relatively new emerging field of research. It may include any research exploring the intersection of the field of neuroscience with the field of education. More specifically,

educational neuroscience includes any research exploring the neural basis of learning and development (S.C. Thomas et al., 2018). This may include research exploring how the developing brain impacts the ability of an individual to learn and effectively process information, or how trauma to the developing brain impacts the subsequent ability to learn as well as emotional and behavioural outputs (Jolles & Jolles, 2021)

1.1. Definition and Principles

The growing field of brain education, often referred to with the term neuroeducation, aims to improve educational practices through a better understanding of the developing mind and the underlying neurobiological mechanisms (S.C. Thomas et al., 2019). Despite some ambiguity in terminology. Neuroeducation can be examined according to the following basic framework: (1) fundamental constructs; (2) core principles; and (3) methodological considerations (A & Barwegen, 2008). The framework defines the base concepts of neuroeducation, describes the principles that guide its developments and applications, and examines its position in relationship to educational research and practice. The core theoretical principles of brain development and functioning learning and memory, plasticity, emotion, social interactions, etc. are outlined. Critically needed methodological approaches to be adopted by neuroeducation in order to be successful are discussed (Kaufmann et al., 2021)

Despite the numerous calls for a new and improved education based on emerging neurobiological findings, there is a conspicuous lack of a coherent framework to define and develop the emerging field of neuroeducation. Support for this need comes from many sources, including a Yale University symposium on "Neuromythology" centred on educational applications of brain research and a position statement on the science of learning and education from the International Society for the Study of Behavioural Development, an influential interdisciplinary organization of behavioural scientists. (Avery et al.2021)

In the latter report, it is proposed that an analysis of the basic principles of behavioural development should be undertaken in order to assess the state-of-the- art knowledge and provide an integrative perspective on it, similar to those which have been developed for the fields covered by the mission of the Academy, such as the "Nature of the Child" project by Cohen, Tesser, and Brenner (Gkintoni et al.2022).

1.2. Historical Development

Neuroeducation, a fledgling branch of study that emerged from the evolution of three existing sciences: Neuroscience, Education, and Psychology, is a new specialty of education initiated by Neuroscience breakthroughs, modern philosophies of education and learning, and the advancement of brain neuroimaging techniques (S.C. Thomas et al., 2018). However, its historical development is still mapped out vaguely and generically. The Historical Development of Neuroeducation consists of eight sections: The Birth of Neuroscience; The Birth of Modern Education; The Birth of Educational Psychology; An Era of Interactions; A Sense of Direction: The Beginning of Cross-Discipline Research; A New Branch of Study Emerges; The Future - A Broadening Perspective (S.C. Thomas et al., 2019).

The historical development of Neuroeducation is traced back to the birth of Neuroscience, Modern Education, and Educational Psychology. The initial generations after the founding of the sciences in the 19th century laid the foundation for cross-discipline research that aimed to understand the relationship between the brain and learning. As the field continued to evolve (Jolles & Jolles, 2021)

In the 20th century, Neuroscience, Computer Science, and Education were actively interacting with each other, refining the objects of study. After these Sciences were stabilized, in the late 20th century and the early 21st century, broader questions were asked, including the oversights and misdirections involved in previous focuses and studies) (Sterratt et al., 2023)

This led to the emergence of neuroeducation as a distinct field of study, with a focus on understanding how the brain learns and processes information (Jolles & Jolles, 2021)

2. Neuroscience Foundations for Learning

The brain is the organ upon which learning is constructed. It is further postulated that broadly, the neurobiological basis of learning can be deconstructed into core principles: learning is neurobiological: learning is a structural and functional change in neural systems; learning is lifelong: neural systems are plastic and learn, and unlearn dynamically across the whole life span; and learning is social: neural systems are contextually reliant, in part on social dynamics and interactions (S.C. Thomas et al., 2019).

Learning requires neural integrity, a foundation of adequate macro- and micro-level health parameters across

the healthy structural, (electro)-biochemical, and (neuro) metabolic spatial domains, and a milieu of supporting resources, including the bioenergy (02) and nutrient (glucose) requisites (S.C. Thomas et al., 2018). The brain has an overarching homeostatically regulated economy on which all learning activities depend. This bioenergetic and metabolic economy, here termed the 'Brain Gold Economy', fundamentally constrains all learning processes, and postulates why connections and interactivity are required for learning to fully optimize and flourish.

2.1. Brain Development and Plasticity

The brain is a complex organ made up of approximately 100 trillion neurons. It comprises several physical structures, such as grey and white matter, and growth and development follow a complex trajectory. However, the progress of brain development is unequal between children and young adults. Brain development from childhood to adulthood involves both neural growth and losses in regions as well as in the connections between them, while the brain overall loses volume with aging Plasticity is generally defined as the capacity of the brain to be shaped by experience, which indicates that there are several widely accepted definitions of plasticity (Ghanbari et al., 2019). Learning, memory formation and recall, perception, recovery from neurological insult, and transient phenomena like critical periods in development result from the same plasticity mechanisms. Moreover, plasticity also changes over time and ages, making for substantial differences during development, maturity, and aging. The brain is not a static organ, and it changes throughout the lifespan. One reason why the very young are so open to learning and formation of high-quality memories is the high degree of brain plasticity at early developmental stages. The brain develops in two complementary aspects, structure, and function (Avery et al 2021).

The anatomy of the brain is specific to remove redundancies from the overproduction of neurons and modify the number of synapses across development Brain functions arise from electric signals in large networks that, in turn, generates spontaneous oscillations, synchronous bursts, and large event epochs, with potentially important developmental consequences (Chang et al., 2021).

Brain development and plasticity are often used as synonyms, where development means brain maturation

at the anatomical, cellular, and systems levels, and plasticity refers to persistence changes in learning and memory. Regarding the malleability or adaptability of the brain, development encompasses those changes that are normal in character, while experience might include unusual events. The plastic nature of the brain and its good development at the early stages ensures that individuals will adapt to their environment, importantly affecting flowers and rhythms of behavioral skills (Leysen, 2021)

2.2. Memory and Learning Processes

Memory is generally viewed as retaining information (cognitive view) as well as having view (behavioral view). In the context of memory formation, the brain is perceived, in a cognitive view, as a data processor with databases storing symbols (information). According to the behavioral view, memory recall is viewed as behavioral retrieval of previously processed information (Guy & Byrne, 2013).

At the same time, for modelling purposes, students need to formulate their own view of the educational process and learning. The most straightforward way is to understand learning in general and the educational process in particular in behavioral terms. Learning is recognized as forming stable behavioral patterns in "response" to instructional activity. The stability of responses depends on the context (either changeable or stable). The educational process can be either adaptive or not depending upon the prospects for change (Ovid et al.2021).

Memory has different configurations, such as encoding, storage, and retrieval. Memory processes are also divided into different categories, such as duration (short-versus long-term memory), content (declarative versus non-declarative), depth of processing (shallow versus deep), transfer (specific versus general transfer), accessibility (available versus inaccessible), conscious involvement (implicit versus explicit), effect on performance (facilitative versus inhibitory), and location (intra-versus extra-cranial). Memory involves different social and basic mechanisms. For example, memory modelling has been the subject of intense research. Now there are various memory models proposed, such as those based on differential equations, computer simulations, stochastic equations, complex networks, multi-levels architectures, and many others. Although these

models differ in their underlying assumptions, qualitatively they allow reasoning about the same memory phenomena (Ghanbari et al., 2019).

2.3 Neuroeducation and cognitive development

Neuroeducation has recently exerted tremendous influence in the higher education system, offering comprehensive insights on the changing functionality of the brain throughout cognitive development. Acknowledging the impact of neurological pathways on brain functions, it was revealed that these variables could alter learning processes and cognition in university students. Hence, neuroeducation has depicted an application in the learning process, in university populations within Lebanon (Howayek, 2024) (Halloun, 2023).

Neuroeducation is a dynamic new field that has implications for educators across all subjects, grade levels, and geographic locations. The definition is both simple and simultaneously far-reaching. Neuroeducation is teaching based on the way the brain learns, the integration of neuroscience with teaching practice. Engaging students across the curriculum with a growing understanding of how the brain learns promises to bring the mediation of education into an exciting new era. Neuroeducation has provided a new perspective in teaching and training objectives. Learning is vital because it will provide ideas for planning education and the development of educational materials, but also for evaluating the impact of the aforementioned issues (Mefteh, 2024)

Reviewing the literature has demonstrated that modern society is continually entangled with neuroscience contributions. Nowadays, educators are more interested in the application of the knowledge about the nervous system's structures and functions to teaching methodologies and education. Neuroscience is an important tool for developing theories of learning and education, as well as helping professionals to design learning environments and study the social context. Neuroscience knowledge complements knowledge from other disciplines. Educational neuroscience explores the development of early brain function and predicts subsequent cognitive, emotional, and learning outcomes (Wilson & Conyers, 2020) (Chew & Cerbin, 2021).

3. Application of Neuroeducation in Higher Education

Traditional education was based on the dissemination of knowledge and information from a teacher to

the students commonly known as the "banking concept" (Azucena Falconi Tapia et al., 2017). However, the banking model does not respect the autonomy of the students, as they become passive and mostly forgetful with the learned content. The traditional method is not satisfactorily efficient for continuing learning attitudes. Considering how the brain learns and applying this understanding to practicum situations could help bridge the gap between learning and education. Neuroeducation is postulated as a novel support to develop and improve educational processes. Neuroeducation is a recent area of education concerned with the application of neuroscience in school settings.

Higher education plays an essential role in the subsequent development of a knowledge-based society. Quality enhancement in higher education is expected to promote a worldwide qualified workforce. Instructors in higher education, however, commonly encounter challenges to efficiently implement student-learning-centered approaches & population content of classes. A potential vehicle for guidance in this context is neuroeducation (S.C. Thomas et al., 2019). Integration of neuroscience knowledge into pedagogical practice is suggested in higher education systems. This could help instructors understand the relationship between learning & the brain and have meaningful applications in practice. The educational process and its relationship with the brain, including mechanisms, relevant concepts, and methodological support of neuroeducation, are presented to understand the motivation for application in higher education. Recent studies of the first application and effects characteristics of neuroeducation in higher education are discussed.

3.1. Teaching Strategies and Techniques

Teaching Strategies and Techniques focus on innovative pedagogical approaches rooted in the discipline of neuroeducation. A systematic presentation of the various aspects of the application of evidence-based teaching strategies and techniques informed by neuroscience is provided. Teaching strategies and techniques have been widely recognized to improve teaching effectiveness and student engagement (Ghanbari et al., 2019), however little systematic presentation has been done on the neuroeducational approaches. Teaching strategies and techniques informed by neuroscience aim to improve teaching

effectiveness or student engagement. Neuromyths are misconceptions that arise from misunderstandings or misinterpretations of neuroscience research. Most frequently cited neuromyths include "we only use 10% of our brain" and "left-brained people are more logical while right-brained individuals are more creative". Since the last decade, neuroeducation has received increasing attention and been regarded as the "missing link" in the evidenced-based paradigm of education. The importance of multidisciplinary cooperation between neuroscientists, psychologists and educators in addressing the educational challenges has been promoted.

3.2. Curriculum Design

Curriculum Design refers to the design of educational curricula, and in particular those curricula informed by or derived from the results of neuroscience. The relevant neuroscientific principles can concern the learning environment, the formation of concepts or long-term memories, neuro-development or the exposure to certain stimuli (Ghanbari et al., 2019). A curriculum is thus a comprehensive plan for active teaching and active learning, including institutional and social objectives. The curriculum typically encompasses 1) considerations of content and substance: 2) locality, time and mode of organization; 3) material, means and equipment; 4) the planned level of learning outcome; and 5) responsibilities and functions of all actors involved in the educational process. Adapting a curriculum to neuroscientific findings typically involves 1) reconsideration of all the aspects of a curriculum to align it with the relevant neuroscientific principles; and 2) reconsideration of the past or present functioning of a curriculum with respect to its educational output (Oswaldo Méndez Mantuano et al., 2019).

To date, the vast majority of neuro-educational activities focus on research and development in neuro-imaging or neuromodulation devices intended for application in the educational domain. These applications probably hope to be of future relevance for evidence-based curriculum design. Meanwhile, many curricula are in need of optimization or refinement with respect to their educational output and social or institutional objectives. Such location and understanding are prerequisite for integrating educational systems or principles based on empirically established and experimentally validated findings from neuroscience. At present, however, this is impossible, and the global educational system and bring with them vast and thriving

neuro-educational domains, schools, activities, and products. In many cases, these initiatives are based on the expectation that neuroscience can bring new insights that will revolutionize education.

4. The Lebanese Education Context

Lebanon's education landscape has distinct characteristics that have shaped its education system. Through the lenses of policies and practices, Lebanese public K- 12 education is characterized by relativism, bi-institutionalism, fragmentation, differential equality, and community-based schools (Esseili, 2014). The Lebanese complex education system consists of two parallel publicly funded sub-systems (a private and a public sector), a disparity between them and different other community based schools that reflect the affiliation of students' communities (religious sects, political groups). This education system is bi-institutional and has been characterized as a 'schooling system under siege' where the 'defeated' public sector is given 'negative autonomy' to function in relative isolation due to the political and sectarian polarization. Education in Lebanon is further characterized by systemic and chronic problems of inequity in terms of access, school resources, teacher qualifications and professional development. Social stratification and inequitable schooling opportunities are the two major concerns in the Lebanese education system. Effectively addressing the concerns requires educational reforms that counteract fragmentation and replicate and extend existing privilege. However, the political environment does not seem conducive to the achievement of long-term and large-scale educational reform. Lebanon has the highest rate of employability in an effort to bridge the gap between education and employment and to better equip students with the relevant skills needed in the job market, yet youth unemployment remains a pressing issue in Lebanon (Addam El-Ghali, 2011).

4.1 Overview

Lebanon has a long exposure to Western educational systems. Post World War II, the monopoly of traditional education, mainly represented by the religious schools and the Lebanese University, started to shatter with the arrival of the French and yet American educational systems. Lebanon, for many years, became the sole country of the Arab world and the Middle East to adopt such imported educational systems. Consequently,

the Lebanese education system has been shaped by the tussle between the imported educational systems and the religious schools, which persisted for long, with a huge influence on the methods, objectives and indeed, the results of education in terms of the mindset, the character, and the behaviors of the students (Addam El-Ghali, 2011).

Broadly, the Lebanese education system is classified into formal education and informal and non-formal education schemes. The majority of Lebanese, around 60%, attend the formal education system, semi-governmental institutions funded mainly by the state. Parochial institutions represent around 35%, a broader group containing schools funded by associations, NGOs, religious groups and the like, which have been founded to apply a particular philosophy of education, agency, and objectives. The remainder of around 5% has been comprised of the private secular educational institutions, which are not profit-centered (Esseili, 2014).

4.2 Challenges

Crisis of Trust: In the 1990s, and following the civil war from 1975 to 1990, the Lebanese government targeted education as a key sector for recovery. From that, a vast growth of private schools occurred, feeding an overall crisis of trust towards the public education system. To avoid the bygone struggles of wars led by sectarian political figures, Lebanese society is enrolling into elite private universities with a concern for prestigious degrees (Abdul-Hamid & Yassine, 2020)

This is ultimately reinforcing a tight link between these institutions and inflation in tuition fees that are above the means of most families. Adopting local currencies for tuition fees is widening inequalities between students relying on the economy in Lebanese Pounds, and those benefiting from foreign currency incomes (Abdul-Hamid & Yassine, 2020)(Nimer & Makkouk, 2020)

On a side note, as far as the younger generations are concerned, a major drop in the number of students registering for the Lebanese Baccalaureate has been monitored since 2020, reaching around half the total in 2022. The Ministry of Education and Higher Education is worried about the evolution of youth choices; with the 1822- age category being the most targeted for emigration. Between the continued monetary crisis, and the pandemic that catalysed online education, there remains an overall catastrophe towards the future of education in Lebanon (Boutros et al., 2022)

Lack of Awareness: The young growing brain has a tremendous potential for learning and should be at the core of all educational policies and practices. But despite the wealth of research and audiovisual raw material available on the topic, neuroscience remains a black box for many educators. The picture painted of the brain in papers, books, magazines or on the internet, often too simplistic, naïve and misrepresenting - mostly classed as neuromyths - doesn't help. The gap between neuroscientists and educators is huge. There is a lack of interest and background knowledge about neuroscience amongst many teachers and teacher trainers. They are often not informed about the nature and importance of the results of neuroscience, until too late. Spiralling on the academic view of the brain cannot at all be a solution for education; it would remove the educators from direct involvement in its study (now that educators' goodwill and intense curiosity are often noticeable).

Research studies show that misconceptions are not only prevailing, but are often systematic even amongst so-called experts. Martineau's longitudinal study evaluated the perceptions of European (research) educators on recent advances in neuroscience. Even five years after being informed, the perceptions had not changed and often were still opposed to commonly accepted insights on brain functioning and learning. In teacher training colleges, the same kind of misconceptions and concerns hinder student-teachers from supporting, or even attending, such initiatives.

Lack of Resources: Compared with other professions, pre-service preparation for school teachers is poor and its current structure wasteful and inefficient. Essential cognitive and educational know-how is generic, theoretically excessive and not aligned with actual professional contexts. Furthermore, teaching continued education, in-service professional development is fragmentary, offering few coherent action plans or impactful programs. Training-of-trainers courses suffer from similar issues.

5. Case Studies and Research Findings in Lebanon

Case Studies and Research Findings in Lebanon have been enriched by the national context with empirical studies. The Lebanese educational system, like other countries, is focusing on the quality of education rather on quantity which urged the Lebanese educationalists to take considerations on the effectiveness of the educational policies and programs during early

childhood level up to lifelong education. Hence, a national interest in evidence-based education, the efficacy of the educational techniques consistent with Lebanese Cro-Magnon moral standards, the social responsibilities in society and classroom, educational brain research, and the political parties sponsored teacher-training programs. Consistent with this growing interest, Lebanese educators, psychologists, and anthropologists have initiated a convergent movement towards neuroscience and education to address the educational outcomes seriously through the up-to-date brain research techniques. Hence, Lebanon, the hub of Middle Eastern academic institutions, may take the lead in providing teachers and educators with the necessary treatments consistent with educational brain research. (Abdul-Hamid & Yassine, 2020)(Sacre et al.2023)

Concrete examples or educative research are surely reflected in a few research endeavours carried out in Lebanon. It consists of research outcomes related to the Lebanese context. It includes the educational brain pedagogies demonstrated largely in empirical studies. They include Whole Brain Teaching in University of Beirut (WBT in UB) (McIntyre, 2011), Evidence-Based Education (EBE) in Lebanese International University (EBE in LIU), Emotional Teaching (ET) in Lebanese University (ET in LU), and the exploration of neuroscience and education initiatives carried out in Lebanon (N & E in Leb). Considering that Lebanon is the fading focus of Middle Eastern academic institutions, and so much research endeavours have been. carried out related to the educational brain focus. Such concrete cases would be worthy pieces of research to address the issues of why and how to implement educational brain research pedagogies as the future of education in Lebanon and beyond.

6. Challenges and Future Directions

Despite its promising impact, businesses engaging in neuroeducational projects encounter numerous hurdles. For instance, finding a scientist who can understand the education sector would be a near-impossible task. Furthermore, neither the education sector nor neuroscientific communities have considered the business climate for educational products in the wake of proposed neurotechnology-driven approaches, despite the burgeoning interest in the discovery of the so-called “neurobusiness” (S.C. Thomas et al., 2019). There are still vast gaps in both kinds of proficiency and

community, including research roles and responsibility for interpreting product claims for educational efficacy (S.C. Thomas et al., 2018). Political motivation in public schools darkens further the rationale for neuroscientific company initiatives in education.

In contrast, public university clients in academia, particularly in liberal arts and humanities, will likely demand input exactly of a critical sort, questioning the ethical, social, and political risks of the neuroeducation trend and finally the corporatization of education. In addition, even if the business model works perfectly well in either, it would be of little educational value.

7. Implications for Educational Policy and Practice

Neuroeducation is an interdisciplinary area of research and practice that aims to provide a new brain-based perspective on day-to-day learning and teaching practices. This paradigm shift provides practical insights into the development and learning of university students and suggests specific educational recommendations. These insights can be used at the macro level to help university instructors and decision-makers make well-informed decisions, which may collectively lead to educational success for the country as a whole. (Gkintoni et al.2023)

Lebanon represents a unique case study because of its self-sufficient system governed by professional councils and steering committees, with limited government oversight up until very recently. More specifically, the country has suffered from internal issues such as political instability and war, which have collectively resulted in significant brain drain and predominantly served as a hub for finance and hospitality educational programs. (Ben Hassen, 2024)(Ben Hassen, 2021)

Basic practical implications can be proposed for each of the three aspects of neuroeducation. In terms of instructional best practices, a combination of visual, auditory, reading/writing, and kinesthetic learning techniques should be implemented in the instruction of university students to cater to a variety of learning styles. The words mentioned in each of the separate techniques we made above can then be incorporated in the instructions or are vital for inclusion in the training process to frame the lessons in a way that will be positively influential for the learners. This selection of words, which are used in the instructions, should be adjusted according to the

technique adopted, and these words are as follows: Visual: see, viewing, graphic, picture. Auditory: hear, sounds like, meaningful sound. Reading/ Writing: read, look, precise details, the written word. Kinesthetic: practical, examples, feels. (Kusumawarti & Subiyantoro, 2020)

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