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Exploring the Nature and Meaning of Theory in the Field of Neuroeducation Studies

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***Abstract*—**Neuroeducation is one of the most exciting research fields which is continually evolving. However, there is a need to develop its theoretical bases in connection to practice. The present paper is a starting attempt in this regard to provide a space from which to think about neuroeducational theory and invoke more investigation in this area. Accordingly, a comprehensive theory of neuroeducation could be defined as grouping or clustering of concepts and propositions that describe and explain the nature of human learning to provide valid interpretations and implications useful for educational practice in relation to philosophical aspects or values. Whereas it should be originated from the philosophical foundations of the field and explain its normative significance, it needs to be testable in terms of rigorous evidence to fundamentally advance contemporary educational policy and practice. There is thus pragmatically a need to include a course on neuroeducational theory into the curriculum of the field. In addition, there is a need to articulate and disseminate considerable discussion over the subject within professional journals and academic societies.

***Keywords*—**Neuroeducation studies, neuroeducational theory, theory building, neuroeducation research.

I. Introduction

NEUROSCIENCE as a field of study is a natural science that attempts to explain the workings of the brain and connected nervous system, the functional architecture of the mind, and how the brain and mind map together [1]. The field is contributing to our basic understanding of the neural mechanisms underlying human development and learning. Recent development of brain imaging techniques such as electroencephalography (EEG), positron emission topography (PET) and functional magnetic resonance imaging (fMRI) have provided extra opportunity for neuroscientists to explore the functional organization of the human brain. In light of these advances, neuroscience has experienced rapid growth over the last three decades and tended to form links with other disciplines. Education is one of such disciplines that by incorporating neuroscience can enhance our understanding of mental and physiological processes involved in learning.

The long attempts towards connecting neuroscience, cognitive science, psychology, and education have resulted in emerging a growing interdisciplinary field of study which has been labeled by different names such as 'Neuroeducation', 'Mind, Brain and Education', and 'Educational Neuroscience. The term "neuroeducation studies" throughout this paper is used to pretty well describe the field as a growing interdisciplinary field based on a synergetic connection between neuroscience, cognitive science, psychology, and education in an effort to improve our theoretical and practical understanding of learning and education. The suffix "studies" is added to best feature the interdisciplinarity nature of the field and distinguish it from single fields of study; as such it has been recruited by other interdisciplinary fields such as "Curriculum Studies", Cultural Studies", "Environmental Studies", "Law studies" and so on [2].

Defining the nature and meaning of theory and theory building is one of the most trajectories in progress of any discipline that perceives itself as a scientific field of study. Developing such a solid theoretical framework, according to Donmoyer, contributes to the advancement of knowledge in the field [3]. This appears to be the case for neuroeducaion studies, which has gained significant advancements over the two past decades. However, not much attention has been dedicated to discussing the theoretical issues in the field.

Although the actual meaning of the theory and theorizing in the field is not clear, the importance of these issues has already been discussed and frankly admitted by some neuroeducation leaders [4]-[6]. For instance, Stein & Fischer emphasize on the need for the theoretical models that span multiple levels of analysis and basic perspectives to offer comprehensive explanations that are grounded in multiple methodologies and focus on processes of learning and development, which are at the center of education [4]. In her influential paper, Immordino-Yang [5] summarizes the implications of affective and social neuroscience for educational theory and intelligently suggests that:

For education to truly benefit from these neuroscientific findings in a durable, deep way, for the full implications to become apparent, educators must examine closely the theory on which good practice is built, to reconcile the new and exciting evidence with established educational models and philosophies [5, p.102].

As already mentioned, most of the efforts however have not been directed toward the nurturing of neuroeducational theory. While the field of neuroeducation as an academic discipline is at an early stage of development, its theoretical foundation has been borrowed from other disciplines (e.g., psychology and cognitive science). Hence, a great deal of efforts and resources need to be dedicated to systematically define the nature and scope of theory and theorizing in the field. This ambition is highly warranted since the field of neuroeducation has provided some new insights for educators to better understand the learning process with implications for how to make more effective curriculum and teaching. Accordingly, this paper situates the nature and meaning of theory in the context of

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neuroeducation. It begins with a definition of theory in general and neuroeducation in particular. It is followed through an overview of the main functions and aspects of theory in neuroeducation. The paper concludes with suggesting some fundamental future questions related to neuroeducational theory that need to be asked and addressed as the field develops.

II. What is Neuroeducationall Theory?

The term "theory" in general can be defined as a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting the phenomena [7]. In other words, theory can be understood as a logically organized body of interrelated concepts, principles and propositions that enable us to describe and explain the phenomena. In this framework, any theory can be distinguished by other theories with respect to the nature of the phenomena within their domain. Accordingly, theory in neuroeducation could be defined as a grouping or clustering set of inter-related concepts, propositions and principles that describe and explain the nature of human learning and prescribe implications for educational policy and practice.

III. What are the Main Functions of Theory in Neuroeducation?

A neuroeducational theory can serve several functions. These include description, explanation, prediction, prescription, and interpretation.

A. Description

One main function of a theory is to provide a description of the variables and their relationships. Description provides an organized body of knowledge in a particular theoretical field. Description According to Ball [8], offers a language for challenge, and modes of thought, other than those articulated for us by dominant others.

The descriptive aspect of neuroeducation theory thus provides us with "what" and "how" events that occur in real learning settings. It requires researchers to inform about ongoing policy issues to make relevant theory. As Dow [9] also explained, decisions about educational reform are driven far more by political considerations, such as the prevailing public mood, than they are by any systematic effort to improve instruction.

B. Explanation

Scientific theory seeks to develop valid and reliable explanation for the phenomena within its domain through the utilization of scientific method. This explanation provides the logic of the relationships and exploring the causes and effects. Explaining the educational phenomenon involves appreciation of its meanings that are constructed by analyzing underlying levels.

C. Prediction

Another function is to provide predictions of the occurrence of as yet unobserved events on the basis of explanatory principles embedded in it. The predictions aspect of neuroeducation theory can be made based on generalizations from claimed hypothesizes under the conditions that events and phenomena are controlled.

D. Prescription

Educational theory in general has both normative and descriptive aspects. According to Imsen [10], the normative aspect seeks principles and procedures to decide about educational aims and content for the purpose of educational planning. The descriptive aspect focuses upon the teaching-learning contexts and the students' learning experiences, in order to understand the educational process. Traditionally and philosophically, these two areas are considered as clearly separated, and there are no straightforward ways from the descriptive ("is") to the normative ("should") approaches to education. In practice however, these two parts of educational theory are intertwined. As Imsen [10] explained, variety kinds of norms and ideals on the one hand, and descriptive and analytical information on the other, may constitute teachers' reflections, and how this "amalgam" is used in practice.

The prescriptive aspect of neuroeducation theory is therefore concerned with both "what" is taught and "how" it is taught to attain the educational aims and is not neutral with respect to ideological or political orientations.

E. Interpretation

The final function of theory in neuroeducation is to provide strong interpretations on the meaning of described phenomena. In neuroeducation, according to Kelly, theories are never abandoned easily, of course, but the disambiguation of claims at the hypothesis testing level using cognitive neuroscience data is likely to place an upward pressure on theories, which are too often contingent descriptions of learning with little specification of mechanism or grounding in the larger set of findings in science [11, p.20],

IV. What are the Most Important Aspects of Neuroeducational Theory?

Related to the above, a neuroeducational theory needs to have several important characteristics to guide research activities. These aspects are interwoven and neither one of them perfectly dominates the others.

A. Philosophical or Ideological Base

While "learning" and "education" are often used interchangeably, they are different in function. It is the dominant educational ideology (normative theory) that generally guides decisions about educational aims and consequently determines what kind of learning is an educative experience and what is noneducative or even miseducative [12], [13]. Educational practice, thus, is always a means to an end. The main point here is that theory in neuroeducation like other fields of education, such as curriculum studies and

philosophy of education, originated from a value base toward a desirable society in the context of an ideology. Consequently, the special character of neuroeducational theory was not only determined by the scientific study of human learning and development, but also determined by the philosophical orientation toward a desirable society. Hence, As Kazepides eloquently suggested:

Educational engagements are normative, implying both knowledge and value criteria. A theory of education that cannot give a clear, accurate, and defensible account of these criteria will be unable to distinguish education from mere training, socialization, miseducation, indoctrination, and propaganda and should therefore be considered primitive and worthless [14, p.458]. He continues to emphasize on this point by asserting that "it cannot guide our thoughts, judgments, and decisions when we engage in educational policy or practice" [14, p.458]. It requires theory in neuroeducation to include normative and ideological elements as an important group of factors influencing school practice. There is therefore no single theory dominating the field. Multiple theories enhance the vitality and dynamism of the field. The application of a particular theory or theoretical approach to research perhaps depends to some extent upon the ontological and epistemological assumptions that reflect the researcher's interests, way of thinking and view or understanding of the world [15].

B. Scientific Foundation

Philosophical foundations of educational theory provide educators with knowledge leading them about what they should do. They however need to be equipped with valid information about what they can do**.** Neuroeducators argue that linking education, psychology, cognitive science and neuroscience gives us more integrated and informative sources of information to study the education of human beings. In this framework, just as medicine draws on several disciplines to solve problems related to human health, neueducational theory draws on the disciplines of psychology, cognitive science, neuroscience, education and other related fields, to deal with problems concerning learning and education. The place of each of these foundations and their interrelationship needs to be clarified.

The role of neuroeducational researchers should be not merely to apply theories made by other related fields, but, they should formulate new integrated theories as well. Neuroscience and other scientific foundations of neuroeducation thus have critical role to support neuroeducational theories rather than derive them [16].

C. Testable in Terms of Evidence

Neuroeducation theory needs to be based on research outcomes. We need to be able to develop theory, question it and even reject it if necessary. Within a post-positivist paradigm, theory needs to meet the criterion of falsification. In other words, it should able to pass the most rigorous tests [17].

From a constructivism view, it is the scientific community that determines the degree of conformity. And with pragmatic criteria that emphasize both educational efficacy and scientific acumen, a theory is subject to rigorous testing of both empirical predictions and practical usefulness. Theory in this context must pass the rigorous practical test of *creating usable knowledge* [4]. Policy makers and practitioners should base decisions on the findings of such knowledge.

V. Conclusion

Defining the nature and meaning of theory and theory building is one of the most important concerns in progressing any discipline that perceives itself as a scientific field of study. While the field of neuroeducation, as an academic discipline, is at an early stage of development, its theoretical foundation has been borrowed from other disciplines (e.g., psychology and cognitive science). Hence, a great deal of efforts and resources need to be dedicated to systematically define the nature and scope of theory and theorizing in the field.

The notion of a theoretical framework is central to this field of inquiry in order to provide a structure for conceptualizing and designing research studies, interpreting data resulting from those studies, and drawing conclusions. This ambition is highly warranted since the field of neuroeducation has provided some new insights for educators to better understand the learning process with implications for how to make more effective curriculum and teaching. We need to be able to develop theory, question it and even reject it through rigorous theoretical analysis. Such knowledge helps policy makers and practitioners to make logical decisions. As a consequence, theory in neuroeducation could be defined as a logically organized body of interrelated concepts, principles and propositions that present a systematic view on the nature of human learning to provide new avenues of dealing with educational problems. Based on this definition, a neuroeducational theory can serve several functions. These include description, explanation, interpretation, prediction, and prescription. Related to these functions, a neuroeducational theory needs to have several important characteristics to guide research activities and practical policies. These aspects are interwoven and neither one of them perfectly dominates the others.

Whereas theory in neuroeducation can and should be directed by the scientific bases of human learning and development, it should be originated from a value base toward a desirable society in the context of an ideology. Therefore, there would be multiple theories varying in terms of different philosophical assumptions and practical solutions. Moreover, neuroeducation theory needs to be judged based on research outcomes to fundamentally advance contemporary educational policy and practice. By this definition, there is no example of neuroeducational theory existing at present. Neuroeducation scholars relate their work to invoked general theories borrowed from other fields of psychology, cognitive science, education and neuroscience.

Although this analysis has focused on some fundamental questions about neuroeducational theory, there are many important questions remain to be further investigated. Specifically, future work needs to be formulated to search:

Where do neuroeducational theories come from? Is there any theoretical model of neuroeducation? Which current attempts have the potential characteristics to be established as theory?

There is a pragmatic need to integrate neuroeducation theory into different courses in the field. There is also need to articulate and disseminate considerable discussion over the subject within professional journals and academic societies

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