

Uniting Strides to Inspire Education — Educational Research and Brain Research

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Abstract

Recent researches in neuroscience and education have indicated a reciprocal relationship between the two research disciplines. Brain research has been contributing potential theoretical and conceptual knowledge on various educational phenomena like cognition, memory, attention, perception and so on. Educational research has been focusing on understanding the biological perspectives of education with a view to supplement its already accumulated knowledge base. Both educational and brain research have their own distinct research culture and research areas. Yet, their recent strides show a tendency to converge on issues related to education. Brain research and educational research have their own strengths and limitations in informing each other.

This paper is trying to highlight the basic concepts, implications, concerns and constraints of educational and brain research in inspiring the field of education. Also, the combined future research prospects of the two research disciplines are discussed.

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Over the recent decades, tremendous progress has been witnessed both in educational research and brain research. These fields have been striving hard to contribute diverse questions, sophisticated answers, refined methodologies and controversial implications to their respective research literature. Today, Education is the one single domain which has been the common target of the research implications of educational and brain research. Brain research with its advanced technology has been constantly trying to unravel the molecules of learning and cognition, whereas educational research has been trying to enrich the already accumulated knowledge base by adding new insights and perspectives to education.

Traditionally, understanding the complexities and potential of brain had been a fascinating research endeavor for the scientists alone. Today, the educators are equally interested to understand the biological perspective of learning and related activities with an objective to enhance the educational productivity. This remarkable shift in the research attitude of educators reflects a sustained belief

that the arena of education can be significantly influenced by the neuro-scientific findings. On one side, the educators are gradually realizing the fact that biological understanding of learning can serve as a powerful catalyst in their educational perspective of cognition, at the other end the neuroscientists are fast accepting the potential of educational research in giving crucial insights on actual classroom learning, which is beyond their scope. This mutual understanding has given rise to significant number of initiatives at the global level to propagate the mutual research power of these distinct research disciplines. This constant engagement of the scientists and educators in uniting their strides in the educational enhancement of classrooms has been impressive as well as controversial. Impressive, for generating theoretical knowledge on cognition, emotion, and motivation and other significant learning processes. Controversial, for the speculative nature of these findings and lack of transparency with regard to its predictive value. Hence, a comprehensive understanding of the basic concepts of the two research disciplines and critically scrutinizing

their scope, implications and mutual constraints is essential to estimate the actual knowledge gap between educational research and brain research.

Educational research- Basic concepts

Research is the systematic inquiry conducted in a discipline with an intention to add knowledge. The meaning of research is impregnated with the features of a discovery. It implies that the phenomena subjected to research is already known to the knowledge community, but lacks transparency. It demands further inquiry for establishing the already accumulated sketchy knowledge. Educational research emerged in the 1890s and was strongly influenced by the disciplines of philosophy, sociology and psychology (Somekh and Lewin, 2005). Educational research refers to the scientific and orderly investigation carried out in the various problems and phenomenon of the context and variables of education. Analysis and exploration of knowledge domain has been the main task of educational researchers. Different authors have given diverse classifications of educational research. Broadly, research in education can be either basic research or applied research. Basic research has generation of theories and adding to the respective knowledge base of the discipline as its major goal. The results of basic research pertain to a larger population and lacks immediate application in real educational contexts. Applied research has immediate application of generated knowledge as its proximal objective rather than adding to the knowledge base. The results of applied research pertain to the sample studied.

Traditionally, educational research has been polarized into quantitative and qualitative research on the basis of the objective and subjective nature of the research data respectively. Objectivity refers to quality of being uninfluenced by the personal interpretations of reality. The numerical value of the data determines the results of a quantitative inquiry. An objective inquiry involves quantifiable data where the analysis yields the same result always. Subjectivity is linked to qualitative research wherein the researcher emerges with his/her own interpretations of the analysis rather than the available external facts. Apart from the above said classification, educational research is classified into exploratory and confirmatory studies based on the presence or absence of theoretical knowledge present about the phenomena studied and into historical, descriptive, causal, correlational, experimental and ethnographic researches based on the kind of information the research yields.

Educational research is embedded with certain pragmatic concerns and constraints that prevent it to produce persistent generalizations of its research findings. Crucial among these concerns is the very nature of the context of education. Educational research deals with the enormous, yet delicate interactions of human beings within the greater context of education. All the diverse channels of interactions taking place in the academic setting needs to be in the

focus of an educational researcher which is difficult to incorporate. The participants are immensely potential to affect the quality of interactions with their varying physical, psychological and social mindsets. Hence, the theories and findings often fail the litmus test of applicability and transferability to diverse educational settings. Also, the educational setting is subjected to constant change in its structure and variables. These changes are equally extended to its structure, curriculum, teaching and interventions, textbooks, infrastructure and so on. Hence, an educational researcher who wishes to formulate educational policies needs to update and incorporate the changes in educational setting from time to time. The policies should include the description of the variables studied and also the post productive courses of action. This is yet another challenge for the educational researcher. Hence, the context occupies a highly prominent status in the educational research due to its power to influence the rigor and result of the inquiries.

Brainresearch- Basic concepts

Brain is a highly powerful intricate structure in the human body which expresses its presence in all the human endeavors; from blink of an eye to gross motor movements to higher order cognitive operations. Hence the brain becomes the intrinsic factor of all inquiries aimed to explore and study human phenomena. Brain research is the research conducted by scientists to study brain and nervous system with an intention to understand how the brain works and what its complexities, potential and challenges are physiologically. Brain research has illuminated the biological basis of human learning. It is concerned with generating knowledge on various cognitive operations like memory, concentration, creativity, comprehension, attention, perception and so forth. Principles of brain organization, neural information processing, literacy and numeracy, emotional learning, plasticity and lifelong learning, synaptic development and critical periods are a few concerns of brain research. According to Zadina (2004), the goals of studying brain research includes:

1. To reach as many children as possible.
2. Addressing the individual differences of learners
3. Diversifying teaching strategies.
4. Maximizing the brain's natural process of learning.

Technology plays a pivotal role in the execution of brain researches. Brain research utilizes a wide array of techniques and technologies to explore the brain activities in the subjects. Brain research techniques are diverse and include invasive procedures like neurosurgery. Brain imaging techniques are the most widely used techniques in brain research. They are broadly divided into two. The first category includes those that provide high resolution spatial information about the brain activity. Functional magnetic

resonance imaging (f MRI) belongs to this category. The second category includes those techniques that provide high resolution temporal information about brain activity. Positron emission tomography (PET) belongs to this category. Both PET and f MRI are used to measure changes in brain activity during relatively longer cognitive engagements and require the subjects to lie static for accurate recording. Electron Electroencephalography (EEG), Event Related Potential (ERP), Magnetic Electroencephalography (MEG), biofeedback and neuro feedback are the other significant brain imaging techniques popularly employed by the brain researchers to analyze the brain state of learners. Optical topography is a recent addition to the brain imaging techniques which is non-invasive and effectively explores brain function. These tools of brain research have both potential and constraints. Understanding the power, limitations and the ethical challenges related to their administration can essentially pave way for integrating the brain researches into the realm of education.

Current brain research promises a refined research culture which will be essentially interdisciplinary where the contemporary models and theories of learning will be rejuvenated on the basis of the brain based perspective of learning. The contemporary theories and models of teaching and learning would be subjected to rigorous tests of fitness according to the neuroscientific evidences. Yet, the prospects run the risk of becoming bleak if the educators fail to comprehend the actual potential and intricacies of the brain. The educators need to be cautious in implementing the brain research findings due to the distinct research cultures of brain and educational researches.

Implications of Brain Research in Education

Knowledge stemming from the brain researches provides a fresh outlook for educators in approaching educational phenomenon. Brain research impacts all the realms of the educational settings ranging from educational theories, foundations, practice, analysis of behavior of learners, pedagogy, instructional interventions, policies and the educational research culture. The validity of these influences has become the matter of discussion and debate between the educators and scientists. Nevertheless, crude ignorance of the brain research insights is not a sign of progressive tendency. Hence, it is essential to comprehend the diverse implications of the brain research in the field of education to educate ourselves about how to make a shift in our present understanding of the variables of education and thereby lead to educational enhancement. The author intends to state the implications of brain research in a consolidated manner to inform the educators about how brain science distinguishes and supports educational practices rooted in a concrete neurological foundation. The implications are briefly discussed below:

1. Brain research creates a platform for merging the knowledge

bases of distinct disciplines like psychology, neuroscience, educational psychology and the like to emerge with evidences which are answers for questions common to all the above said disciplines. The research evidences are the common solutions of similar questions perceived and framed differently by these disciplines.

2. Analysis of learner behavior has been traditionally viewed in a psychological perspective. The advanced brain imaging techniques provide a supporting framework for educational researchers to include neural processes in their analysis to enhance their understanding of the complex behavioral patterns exhibited by learners in diverse educational contexts. PET, f MRI, EEG are a few such potential techniques which measure brain activity during cognitive and behavioral engagement.
3. Brain-research challenges our traditional foundations and philosophical assumptions about the teaching strategies and in turn influences our initiatives on training the educational professionals including the teachers and researchers.
4. Brain research gives powerful insights on the physiological and neurological foundations of learning and thereby provides essential guidelines in designing the educational, in particular the instructional intervention programmes aimed to increase the educational outcome.
5. Brain research enables the educators to have a comprehensive understanding of the basic physiological processes common to all individuals as well as appreciate and comprehend the concept of individual differences in the actual classroom teaching.
6. Educational policies are also affected by the brain research findings. The research evidences instill a need for seeking ways of designing scientifically firm curriculum and in turn frame efficient educational policies.
7. Traditional intellectual dichotomies like nature and nurture, plasticity and periodicity and concepts such as critical periods, sensitive periods etc have always fascinated the intellectual inquiries of educators and scientists. Brain research with its advanced technological support is constantly unraveling and illuminating these quests with its scientifically grounded explanations and theories.
8. Brain research has the potential of resolving the existing confusion among the educators on the biological perspective of learning. The major areas where brain research has been gradually supplementing its research knowledge includes the identification of key sensitive areas in the development of human brain, underlying physiological

etiology of learning disabilities like dyslexia, dyscalculia, attention deficit hyperactivity disorder and many more atypical brain pathological conditions exhibited by learners in the educational context, limits of brain potential, role of emotions in learning etc.

9. Brain research enables a better understanding of the brain processes involved in cognitive processing. If an educator has successfully comprehended the physiological perspective of learning of a specific subject, it can provide valuable guidance in analyzing the true reason behind difficulty of his students in learning that particular subject. This in turn empowers the educator to adapt that subject teaching through changing the pedagogy.
10. Principles stemming from the brain researches have valuable implications for designing and developing a brain compatible learning environment. The Principal elements of a neurofriendly learning environment includes emphasis on affective learning, incorporating multiple strategies for instruction, adopting scientifically attuned teaching methodology for language and other subjects confirming to the respective neuroscientific findings, practicing contextual teaching through practical simulations, connecting knowledge to society and creating a culturally sensitive learning environment.

Constraints and Concerns of Brain Research in Inspiring Education

In the past two decades, brain research has emerged with findings interesting and valuable for educational research to rethink and shift their perspectives on education. We have briefly discussed the role played by the neuro-scientific findings in informing all the realms of education. Despite all the glorious achievements, brain research is still struggling hard to carve a stable niche in the educational research community. Brain researchers have not yet been successful in becoming the mutual partners of educators in their mission of unraveling all the unexplored elements of learning and education. The crucial factor behind this failure of brain researchers are the inherent scientific, pragmatic, philosophical and ethical challenges and constraints that are making their research findings incompatible to merge with the realm of education. Also, the educational researcher are having inherent constraints and challenges specific to their research culture that has been making it impermeable for neuroscientific findings. In other words, the major factor detrimental for these mutual constraints of the research fields is the distinct nature of the respective research cultures.

Major Concerns and Constraints in the Union of Brain Research and Educational Research

An overview of the main elements of friction in the union of education and brain research is as follows:

1. The nature and range of the research context shows vast diversity. The context of brain research is the brain of an individual. The limited area of the brain technique is sufficient to provide an accurate index of the variation in the context. The context of educational research is the enormous academic setting at large and the psychological field of the learner. Learning is a function of the complex interactions of participants with all the elements of the broader context. Hence, educational researchers are capable of efficient orchestration of all the essential elements of the broader academic setting to increase the learning outcome, which is beyond the scope of brain researchers.
2. Uniqueness of human brain poses challenge in implementing the brain research findings. It becomes a tedious task to generalize the findings of brain research in understanding the learner's innate motivation, attention and cognitive style as every individual is unique. It demands an accurate analysis and quantification of both the interpersonal and intrapersonal fluctuations in the cognitive performance at diverse situation and diverse temporal settings to gather a reliable data on learning processes.
3. The highly controlled and artificial research environment combined by the complex technical complexities of brain imaging techniques like MRI and PET create problems in conducting studies with young subjects. Most of the brains imaging techniques demand the subjects to remain motionless for accurate recording. The tools of educational researchers demand no such controlled behavior from the participants because learning is a natural process, seen from an educational perspective.
4. The highly localized nature of brain research data is unable to provide specific recommendations to teachers on the designing and selection of the best instructional strategy for teaching a particular subject. Brain researchers gather and process data on specific areas in brain and try to find out the correlates of the respective function executed by the identified area. This microscopic biological information is of no direct use for the educators in understanding how the neural correlates can be practically included in designing the instructional methods. Hence it becomes too difficult to grade up the knowledge in neural correlates and brain localization in the quest of educators to understand cognition operating in the wide educational context.

5. Educational research and brain research has its own distinct and established vocabulary and glossary. Educators are concerned to study learner behavior in terms of motivation, interest, readiness, efficacy, attitude and so forth. neuroscientists are concerned to dissect the learner and learning into terminologies like neurons, ganglia, synapses, neurotransmitters, white matter and Grey matter, neural stimulation, resting potential and action potential and so forth. Hence, describing an educational phenomenon in blended terms would be of no practical utility to either group of practitioners. An operational definition of a learning behavior which is mutually relevant and useful is a highly tedious task
6. Brain research tools and methods are expensive and demand high level technical expertise for giving valid and reliable results. Therefore, the educational researchers find it challenging to simulate the neuroscientific findings in actual classroom settings without which even the most crucial neuroscience finding is not successful in carving a place in educational research literature.
7. Brain researches have been to a significant extent providing insights on the biological basis of human learning based on their studies on atypical brains or in other words based on their investigations on brain pathologies. Atypical brains differ from typical brains in their biology and operations. Hence, it is difficult for educators to implement these brain findings on a community of average learners who exhibit conforming patterns of behavior.
8. A widely endorsed limitation of brain research is its inefficiency in giving the educational phenomena a framework which can be easily imbibed into the already accumulated educational perspectives. In this regard, Schumacher (2007) suggests that while neuro scientific studies may be able to inform psychological understanding about learning, its biologically privileged learning is of no direct interest to educators.
9. Growing ethical concerns about the use of neuroscientific methods and their applicability in understanding the neural networks and activated regions has increased the knowledge gap among the researchers of two fields. Identifying the zenith of brain examination, cautious use of brain scanners, subjecting atypical brain to research, occurrence of accidental pathologies during examination are all ethical issues to be considered beyond knowledge boundaries. After all, they are human brains and that matters a lot.
10. Growing fear of losing their respective research identity in their effort to collaborate in inspiring education has induced unprofessional inhibitions in both educators and neuroscientists in extending efforts to move beyond

boundaries. Educators fear that incorporating brain researches too their arena might make the educational system too scientific to practice. Neuroscientists fear that a constant shift of their research interest to a macroscopic context like education would be a threat to their unique reductionist approach.

Possibilities for a Compatible Union Between Educational Research and Brain Research

Brain research has been constantly giving biological insights on the psycho-social process of learning. Educational research is slowly transforming its research thrust to the exploration of scientific basis of the educational phenomenon. The inherent concerns and constraints related to research disciplines narrow the scope of compatible union. Nevertheless, revisiting and rethinking of the concerns can transform them into potent future prospects and opportunities of mutual relevance. Discussed below are the major ways which can enable and empower a compatible union between the educational research and brain research.

1. Adopting an interdisciplinary approach by designing a mutually convenient and conforming research vocabulary between the brain scientists and educators. Initial step would be to undertake brain researches into areas and phenomena where educational researchers have already framed working hypotheses and are in their way to test the framed hypotheses.
2. Non-competitive and empirical collaboration between the educators and scientists would help pave ways for creating a mutually beneficial research platform that serves a common ground not only for exchange and learning of respective research knowledge, but also a platform to discuss, differentiate and realize the strengths, limitations and respective research culture.
3. Educators need to make a significant shift in their approach towards analyzing the fitness of brain research to education. Rather than pondering upon the contributions of brain research to education, they need to examine the empirical contributions of educational research to brain research. Also, they need to identify the major thrust areas where their research knowledge has failed to generate a valid generalization and to which brain research can provide potential insights. This kind of interactionist approach would enable the brain scientists to focus on educationally relevant areas rather than emerging with biologically overloaded explanations of phenomena that has no direct relevance in classrooms.
4. Brain researchers need to research on designing innovative and cost effective neuroscientific research tools that can be effectively handled with a minimum level of expertise by

an educator. Also, they need to equally concentrate on examining typical brains too for developing theories and models of learning and development that can be constructively implemented on a greater proportion of people with average brain.

5. There exist several areas and research questions in learning and development which the brain scientists are not adequately informed to approach and research. These include the nature and development of advanced forms of cognition, its growth and development, role of life experiences that has the power to affect brain processing during specific periods of development and so forth. Educational research has already accumulated significant knowledge base on the above mentioned processes. Educational researchers need to share their accumulated knowledge with the brain scientists. Otherwise brain researchers are more susceptible to running the risk of generating theories of very little scope of generalization. The scientists would be forced to delimit their research context to a significant extent. The context would be built purely on personal experiences of how a child is introduced to the process of learning different subjects, content areas, skills and knowledge.
6. Brain researchers should largely concentrate on conducting analytical inquiries rather than exploratory ones. Rather than generating inferences on a novel content, it is valuable to analyze a widely researched educational area by employing novel methods and techniques. This would contribute to the knowledge base of neuroscience in the identified content. Practicing similar strategies on educationally relevant research contents would enhance the stake of brain research in the realm of education.
7. Bridging the existing communication gap between the neuroscience and the social scientists. The various ways leading to resolving the bridge between the two research communities are already discussed. Apart from the above mentioned ways, practicing ethics in research is yet another way of reducing friction between the two research disciplines. Goal of research need to be solving a problem rather than an urge to create an identity for oneself. Such an attitude would shift the focus of research to problem rather than discipline. Both educators and neuroscientists should concentrate on inquiring about phenomenon, the solution of which holds theoretical and practical support for both and yet which cannot be approached alone.
8. Educators and neuroscientists need to harness a research relationship that is essentially reciprocal and expressed in a common vocabulary. This would enable a constant bi-directional flow of knowledge and lead to development of

an educational practice that is essentially informed by neuroscience and yet has been tested on real educational settings. Continuously and comprehensively updating the research findings in diverse educational contexts would definitely help in refining the findings. Educators can reduce the misconceptions and misunderstandings by practicing a trans-disciplinary approach to analyze educational phenomena.

Looking forward- Potential Research areas for Future Collaborated Research

Educational research and brain research have been striving to inform each other with their respective research findings. Neuroscientific evidences have been providing a more scientific perspective to learning and education. It is contributing towards a more empirically based biological understanding of brain processes during cognitive engagement. Educational research has been helping brain research in identifying research areas relevant to the actual academic context i.e. classroom. Despite the enormous gulf of concerns, constraints and basic cultural differences between the research cultures of the two research communities, there are research inquiries at the junction of these two disciplines which demand a complementary research from both sides to illuminate and resolve the existing misconceptions and generate solutions which hold high theoretical and empirical value for both the research communities. A few such key research areas are discussed below. The list is not exhaustive and also includes areas which have been already subjected to rigorous research, but is still in its infancy. Below mentioned research prospects needs to be within a framework of mutual appreciation for all efforts directed towards knowledge generation by the two research disciplines.

1. Specific locations of different types of knowledge in the brain and the way they show fluctuations through learning.
2. How exactly does the nature of learning environment influence brain functions?
3. Comprehensive understanding and identification of the sensitive periods in learning of different subjects.
4. Better understanding of the deviant brain functions in individuals with learning disabilities. Brain research has already offered powerful insights on learning disabilities like dyslexia. Yet, much more needs to be explored before we are able to give specific recommendations to the instructors on the selection of the best teaching strategy in teaching these special learners.
5. Can differences in cognitive styles be attributed to differences in cortical information processing?
6. Further refined research is demanded on role of emotions in learning. Advanced neuroscientific methods need to be

employed to unravel the changing response of amygdala, the emotional seat of brain, towards different kinds of learning environments. Also, the research can be extended to diverse population like preschoolers and adolescents to analyze the differences in the neurobiological mechanisms which regulate the relationship between learning and emotional stimuli.

7. How do the spatial memory system and the rote memory system in the brain consolidate memory during stressful learning and relaxed learning?
8. Although neuroscience has produced valid evidences on the link between aging and memory, further investigation is needed to illuminate concepts like diminishing executive functioning and increasing knowledge, aging and strength of learning, learning as a brain vitalizer etc.
9. Rigorous research is needed to analyze the limitations and constraints of laboratory findings in forming broader generalizations about a phenomenon to diverse contexts.
10. Adequate confirmatory neuroscientific studies need to be conducted to better understand the impact of favorable living environment in brain processing. A specific area of focus would be to explore the link between effect of proper nutrition, high socio-economic status and material comforts on capacity of neural processing. Brain imaging techniques can give tremendous potential insights on the differences between a nourished and a malnourished brain.
11. Does different patterns of cortical activation do exist in the brain depending on the nature of the content to be learned? To be specific, are there any organized general patterns of cortical activation patterns for verbal, spatial, linguistic, musical, bodily kinesthetic, mathematical, logical, visual and social skills in the brain?
12. Rigorous research needs to be performed on the intervention strategies that can be implemented in the classrooms for overcoming test anxiety and other correlates of diminished cognitive processing.
13. A specific focus area of global concern is to study the role of brain in transforming normal adolescents and children into deviant individuals. What is the part played by brain in designing their destiny and how far can education and favorable bio-psycho-social environment bring changes in these neural-grounded deviant behavior patterns.

Conclusion

This paper has attempted to highlight the various existing thoughts and speculations about the nature, status, differences and role of educational and brain research. Ultimately, the two research

communities are assumed to impact education and educational practice. The topic is introduced with a brief discussion on the basic concepts of educational and brain research. The various ways by which brain research is influencing has been briefly analyzed followed by description of the major scientific, pragmatic, ethical and other concerns and constraints in the path of a compatible union of these two distinct research communities. The concerns have been given a framework of future fresh possibilities of collaborated work in the discussion followed. The paper ends on an optimistic note by sorting out a few key research areas that demand a complementary research from the two research disciplines.

The current state of relationship between the two fields makes it difficult to make practical comments on how far the educators can benefit from lessons from brain research. Further Confirmatory studies need to emerge to substantiate the present sketchy knowledge of neurobiological basis of learning. We need to examine the effectiveness of neuroscientific studies in the classrooms and employ their results for further refining of research directions. An attitude of cautious optimism and a non competitive research outlook would definitely pave way for dissolving the existing bridge between the two research fields. The practitioners of education and neuroscience must be aware of their mutual strengths, limitations and cultural differences and focus on areas which are at the interface between the two fields and the solution of which cannot emerge in isolation. Although it cannot be expected in the proximal future that our schools can be orchestrated with neuroscientific findings, but we can hope that brain science would definitely emerge with more educationally feasible research findings that would resolve certain educational misconceptions. An active and more intelligent combined research would certainly give rise to future intellectual inquiries that would lead to a series of further potential questions and answers.

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