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Foundations of cognitive education: Issues and opportunities

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Abstract

Researches on the functioning of the mind and brain, particularly during the past decade, have greatly enhanced our understanding of learning, memory, intelligence, and emotion, all of which have fundamental implications for education. Such efforts have led to the emergence of a new multi-disciplinary field called cognitive education, though the potentials and limitation of this flourishing field have not yet been addressed clearly so that it could be introduced as a field of study. The main purpose of this study, accordingly, was to enhance the existing clarity, and understand the amplitude of cognitive education by focusing on some fundamental features of this emerging field.

Keywords: Cognitive science; cognitive education; cognitive science foundation of education

1. Introduction

What is cognitive education? Is it an academic discipline? Does it have a specific definition, history, and methodology? There are many such a questions that we probably couldn`t find clear answers to in previous studies of the field. The main purpose of this study is enhancing clarity and understanding of amplitude of cases in question by focusing on some fundamental features of this emerging field and explaining some important dimensions of cognitive education.

Knowing how our minds/brains function, how we use the brain and body to process and store new information, how our minds/brains change and develop, and how damage to our brain contributes to disabilities and other problems – all these research efforts have great potential for moving forward the science and practice of learning (Fischer & Daley, 2006).

Cognitive education may be defined as an approach to education that is based on cognitive science studies (mind and brain researches) and focused upon acquiring, developing, and applying cognitive processes to realize qualified learning. Historically, cognitive education is most pronouncedly expressed in the writings of great thinkers such as Jan Piaget, Leo Vigotsky, Jerome Bruner and the large group of their followers. However, the current approach principally lies in the intersection of mind/brain and education studies, and some institutions around the world, including in Iran, have established cognitive education departments for a better understanding of learning and

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teaching in order to design and develop more effective educational programs and policies. In addition, there are some special journals (e.g., *Journal of Cognitive Education and Psychology*, and *Journal of Mind, Brain, and Education*) that support publishing studies related to cognitive education. Methodologically, cognitive education is a wide field embracing a rich variety of different methodologies, from laboratory experimental methods to qualitative methods. As the field is highly interdisciplinary, research often cuts across multiple areas of study, drawing on research methods from psychology, neuroscience, linguistic, artificial intelligence, and philosophy.

While cognitive education has its specific concepts, tenets, history and methodology, it is a multidisciplinary field which supported by cognitive science foundation. Although cognitive education nourished from other cognitive sciences (such as neuroscience, psychology, philosophy of mind, linguistic, and artificial intelligence), cognitive education has some implications and applications for cognitive sciences too. It means that a full understanding of mind requires attention to all of these multiple-interrelated facets and it is certainly obvious that cognitive education has posed questions about how minds actually work. Hence, cognitive science could in principle, and in practice, improve our understandings of brain, mind, and learning, and the education profession could benefit from embracing rather than ignoring cognitive sciences. Consequently, educators should be actively contributing to the research agenda of future cognitive science research. It could be hoped that this article to be considered as a primary step in this way, since to reach an inclusive overview, firstly, it should be reviewed and deducted some important aspects in cognitive education such as its conceptual definition, historical development, research methodology and its relationship with cognitive science.

2. The nature of cognitive education studies

Researches on the functioning of the mind and brain, particularly during the past decade, have greatly enhanced our understanding of learning, memory, intelligence, and emotion, which have fundamental implications for education. The attempts toward using of these understandings lead to emerging a new field by different names that are used interchangeably such as "learning science", "mind, brain and education" and "cognitive education" and etc. However, as Haywood (2004) pointed out all of these programs that they introduced can be placed under the more generic term "cognitive education". Because it can subsume a wide variety of educational programs under one broad philosophical system.

The psychology of cognitive development, Piaget´s and Vygotsky´s theories in particular, were very influential in the second half of the 20th century. These theories drastically changed our conception of children's learning and understanding capabilities in different phases of life. But, in more recent years, education draws on research and theory based on cognitive science in order to develop powerful learning environments, to foster conceptual change and support instruction in different subjects, such as mathematics, science, astronomy and etc.

The goal of this field as a cognitive education (albeit Sawyer, 2006, p: xi has called it as learning science) is to better understand the cognitive and social processes that result in the most effective learning, and to use this knowledge to redesign classrooms and other learning environments so that people learn more deeply and more effectively.

In fact, cognitive educators develop an educational process and environment that is focused on the grasping of big, powerful ideas, but that gives students a remarkable degree of responsibility in working with those ideas. That is what Scardamalia and Bereiter (2006) and Bereiter (2002) describe it as "Knowledge Building", or "knowledge creation" that focuses on continuing process of idea creation, development, and improvement. In the process of knowledge building, the knowledge workers naturally learn, and such learning is essential to their careers as knowledge builders. Then, cognitive approach to education considers educational phenomena differently from traditional approach. Some of their differences are summarized in the following table:

Table 1. Comparison of traditional and cognitive approach (Bereiter, 2002)

Cognitive approach	Traditional approach
knowledge construction	knowledge transmission
reasoning	memorization
learner centered	teacher directed
collaborative	competitive
opportunistic	tightly schedule
idea centered	fact centered

Therefore, cognitive education is a new discipline that has specific history, methodology and issues. The most important issues in cognitive education studies that outlined by outstanding writers in different places consist in what Sawyer (2006) stated as the relationship between learning and educational theories; whatever Goleman (1995) and Ledoux (1996) named the impact of emotional components on cognition and education; what Ashman and Conway (1997) have discussed in a way about the relationship between motivation and learning; whatever Bruner (1996), and Raeff and Benson (2003) represented as the nature of human development and the impact of social and cultural forces on human development and educational theory, policy, and practice; and more recently what Howard-Jones (2010) introduced as a neuro-education studies may have multiple implications in educational domain.

3. Relationship between education and cognitive science

Cognitive science that studies the mind is an interdisciplinary field which draws upon many disciplines including neuroscience, psychology, philosophy, computer science, artificial intelligence, and linguistics. Glaser (1988) in "Cognitive science and education" has defined cognitive education more consciously as "a federation of psychology, linguistics, and computer science which offers a re-conceptualization of the nature of the learning process and new approaches to the investigation of mental functioning". Since the purpose of cognitive science is to develop models that help to explain human cognition – perception, thinking, and learning (OECD, 2007) that are studied in education too, the study of thinking, learning, and memory links education to the cognitive sciences (p. 252).

In the recent decades since the cognitive revolution took place, many advances have been made in our understanding of how people think and remember, as well as in what people know about what they know— that is, their meta-cognition (Metcalfe & Kornell, 2007), while before that, educators paid little attention to the work of cognitive scientists, and researchers in the nascent field of cognitive science worked far from classrooms. Today, cognitive researcher are spending more time working with teachers, testing and refining their theories in real classrooms where they can see how different settings and classroom interactions influence applications of their theories (Bransford, Brown, & Cocking, 2001). Indeed, educators ought to be able to think about educational issues from a number of points of view. Perhaps at most, they will have attained disciplinary expertise in one or two standard disciplines. However, they ought to have enough of a familiarity with other relevant disciplines so that they can at least participate meaningfully when important issues are being addressed (Gardner, 2009). Yet, our increasing understanding of educational foundation based on cognitive sciences requires a serious cooperation and authentic interaction between cognitive scientist and educators. In fact, the communication with practitioners may become a key factor influencing the success of attempts to enrich classroom practices with scientific understanding about the brain and mind (Pickering & Howard-Jones, 2007). It is important to take into account the "*The Language Game*", a legacy from Ludwig Wittgenstein, when people from different cultures interact. This is a vital point when trying to build bridges to be able to communicate between different disciplines and when trying to describe concepts within neuroscience by the use of everyday language.

So, although cognitive science is a valuable and informative source that can feed educational theory and practice, there are several ways that education can inform cognitive science as well. For example, as Sprenger (2003) pointed the study of differentiation practice as related to perceived learning styles by teachers can identify preferences for memory storage. Moreover, educational settings can confirm or deny findings in neuroscience labs by offering setting for environmentally valid settings (Fischer et al., 2007). So, hypotheses in psychology which have been

confirmed in neuroscience should take a further step and see what evidence is found in pedagogy to support the same claim (Johnson, Chang, & Lord, 2006). Therefore, establishing a strong connection between education and other cognitive sciences as pointed out in OECE (2002) require:

a. Develop a creative dialogue between several disciplines and interests (cognitive neuroscience, psychology, education, and policy);

b. Discover what insights in cognitive sciences might offer to education and educational policy and vice-versa;

c. Identify questions and issues in the understanding of human learning were education needs help from other disciplines.

In short, as mentioned before, our understandings of brain, mind, and learning could be modified by cognitive science, and the educators and educationists could benefit from cognitive sciences, there upon, educational practitioners and researchers should be contribute actively to the research agenda of future cognitive science research.

4. Methodological issues in cognitive education studies

Cognitive education is a wide field embracing a rich variety of different methodologies, from the laboratory experimental methods, to the qualitative methods. As the field is highly interdisciplinary, research often cuts across multiple areas of study, drawing on research methods from psychology, neuroscience, linguistic, artificial intelligence and philosophy.

However, when attempting research in the social and behavioral sciences, we are faced by many constraints because of the difficulty of explaining, predicting, and controlling situations which involve human beings. Observations are difficult to conduct, measurement of behavior is difficult, and ensuring that the conclusions and implications of research are unflawed is also difficult. One of the half-truths encountered by those working in the education field has been the belief that 'real' research must be high-powered, statistics driven experimentation. This is far from reality as 'good' research and the application of the scientific method can be found in surveys, interviews, and observation as it can be in laboratory experiments (Ashman & Conway, 1997).

Regardless of the purpose, much of the criticism of research reflects the perceived chasm between what commonly occurs in tertiary institutions in the name of research, and what takes place in the field, in the name of education practice (Ashman & Conway, 1997). In cognitive education, as in any applied field, three kinds of research are relevant. There is basic research, aimed at understanding the phenomenon or problem of interest. There is decision-oriented research, aimed at identifying "best practice" and guiding policy decisions. Then there is research-based innovation, which is the engine of progress in an applied field. "Research-based innovation", however, is research aimed at creating innovations. The first two kinds of research have long been recognized in education, but the third is only beginning to gain recognition. During the 1960s, the US National Academy of Education commissioned a report on the role of research in the improvement of education. The report, by two leading education researchers (Cronbach & Suppes, 1970) recognized only the first two kinds of research, which they labeled "conclusion-oriented" and "decision-oriented" (Bereiter & Scardamalia, 2007 p. 18). While in the educational studies, we strongly need to the research-based innovation to overcome the main problems.

Research-based innovation in the cognitive education has given rise to a number of promising new approaches, including Fostering Communities of Learners (Brown & Campione, 1996), Problem-Based Learning (Evensen & Hmelo, 2000), Learning Science by Design (Holbrook & Kolodner, 2000), Constructionism (Kafai, 2006), Knowledge Building (Scardamalia & Bereiter, 2006), the Web-based Inquiry Science Environment (Linn, Davis, & Bell, 2004), Cognitive Tutors (Koedinger & Corbett, 2006), Central Conceptual Structures (Case & Okamoto, 1996), and certain refined versions of Project-Based Learning (Lee & Songer, 2003). A common view seems to be that these are merely procedural variations on constructivist or social-constructivist learning, which has its roots in the work of Dewey, Vygotsky, and Piaget. This may be true at a gross level of description, and the belief is encouraged by the tendency of innovators to compare their approach to a stereotypic traditional approach (lecture, recitation, and seatwork) rather than comparing it to nearer neighbors. We have argued that there are important – indeed, fundamental – differences within the broad family of social-constructivist approaches, and that these need to be examined if education is to progress (Bereiter & Scardamalia, 2003, 2006).

Then, because of interdisciplinary nature of cognitive education, researchers in this field should be relatively familiar with research methods in all fields of cognitive science, so that they would be able to translate their finding educationally. As Gardner (2009) says 'an educator should at least understand the input from these various disciplines, synthesize it, and make a recommendation that could be defended to critical experts and justified to an often skeptical public of students, teachers, principals, and parents'. He hopes that in future educators will have the kind of training that would allow them, in his terms, at least to do these disciplinary "hats". While educators should strive to master a "multiple-perspective" approach, scholars in the new area will need to achieve a more ambitious goal. To do original research in mind, brain, and education (MBE), a person must become a genuine interdisciplinarian, able to deal substantively with the relevant areas of biology, psychology, and education.

5. Conclusion

As the Son & Vandierendonck (2007) remind us, the fields of cognitive science and education have worked hard to discover effective principles of learning with the goal of improving educational achievement; therefore the move toward a cognitive approach to education has seen the development of a considerable number of general strategy training models that seek to teach cognitive strategies either within the context of specific academic content, or without alignment to any specific teaching area. But the majority of these models – although not all – satisfy a number of underlying principles, similar to those outlined by Houck (1993), who stressed on learning that occurs within a curriculum context is preferable to learning in isolation; however instruction and learning experiences should be integrated and balanced. Indeed, it is worthy of note that instruction occurs as a continually recurring (recursive) process where learning on new tasks builds upon previously acquired skills, so mediation by teachers and others should be assisted the learner to focus on the task. Also instructional routines and thinking aloud methods are included to provide good models of strategic thought, despite this it must be considered that new knowledge is always related to existing knowledge. However, this need to focus on importance of scaffolding that allows the learner to take control of content and process; as such, peer-mediated learning is supported to motivate and assist students to gain insight into other students' problem-solving behavior. Moreover, as Ashman & Conway (1997) emphasize, immediate feedback is provided on the success of problem-solving behavior so that the student can make adjustments as needed.

In sum, cognitive sciences foundation of education has rewarding applications and implications for educational theory and practice, yet deducted educational principles of cognitive science do not always make successful transitions from the laboratory to applied settings and have rarely been tested in such settings. Without doubt, as Ashman and Conway (1997) pointed out these are the main concerns of many cognitive education researchers that are moving toward classroom-based research.

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