Directions for Mind, Brain, and Education: Methods, Models, and Morality

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ABSTRACT: In this paper we frame a set of important issues in the emerging field of Mind, Brain, and Education in terms of three broad headings: *methods*, *models*, and *morality*. Under the heading of *methods* we suggest that the need for synthesis across scientific and practical disciplines entails the pursuit of usable knowledge via a catalytic symbiosis between theory, research, and practice. Under the heading of *models* the goal of producing usable knowledge should shape the construction of theories that provide comprehensive accounts of human learning and development spanning multiple levels of analysis. Under the heading of *morality* usable knowledge must be put to *good* use: Its application and dissemination ought to be infused with moral considerations gleaned from dialogue among all those potentially affected. Generally, the field should be shaped not only by its constituent scientific disciplines but also by its applications to education and learning. Thus we argue for the adoption of a kind of *pragmatism* that would be best actualized by building research-school collaborations between researchers and practitioners.

The emerging field of Mind, Brain, and Education (MBE) is growing fast, both as a field and as a movement, marked by the founding of the International Mind, Brain, and Education Society (IMBES) in 2004 and its journal *Mind, Brain, and Education* in 2007. MBE makes possible the coalescence between disparate fields of research and various arenas of practice. As in any complex interdisciplinary endeavor MBE produces many open questions both empirical and theoretical, with more opening every day.

Over the past decades MBE has been making great strides that include formal steps to officially mark a new field of research and practice (Fischer, Immordino-Yang, & Waber, 2007). Alongside the Society and Journal, there are graduate-level programs in MBE springing up around the globe in places like Cambridge (England), China, and Texas (at Arlington/Dallas). The first such graduate-level academic program was started at the Harvard University Graduate School of Education in 1999. This masters program is characterized by a yearlong core course in cognitive development, education, and the brain (Blake & Gardner, 2007). The training of a new generation of educational researchers and practitioners has begun. The field is poised to usher in a new era in both the science of learning and scientifically based educational reforms. Of course, any movement this exciting and potentially important is rife with complex considerations.

In this paper we organize a set of important considerations around three themes: *methods, models,* and *morality.* Methods involve issues of quality control and interdisciplinary synthesis. The emerging field of MBE will be best served by a methodological symbiosis between theory, research, and practice. The idea of a *research school* (Hinton & Fischer, 2008; Schwartz & Gerlach, in press) embodies the methodological innovations we have in mind and also grounds our reflections about

models and morality. Models concern the types of theories that best suit the problem-focused interdisciplinarity that characterizes MBE as a field. We suggest that comprehensive models of human development that span multiple levels of analysis are the most desirable and that their validity is best determined through broad *pragmatic* criteria. In MBE, models must prove their worth by generating usable knowledge. Regarding morality, MBE methods and models must ultimately be put to *good* use, entailing that the moral issues at stake are placed openly on the table.

The goal of this paper is to trace *directions* for MBE, not to forecast its development. Suggesting directions for MBE goes beyond merely outlining what is possible or probable to considering what is preferable. In this paper we aim to contribute to informing and shaping this young field.

Methods: Problem-Focused Methodological Pluralism

Mind, Brain, and Education is a problem-focused interdisciplinary field that seeks to bring together biological, psychological, and educational perspectives, with the express intention of improving educational practices. Advancing a field this complex entails certain methodological innovations. We see a set of unique quality control issues shaping the direction of these innovations. Importantly, the methodological innovations that MBE requires frame the discussions about *models* and *morality*.

Being problem-focused and interdisciplinary, MBE must meet unique demands for quality control. Key directions for methodological innovation stem from two different problem areas and converge on an emergent mode of knowledge production, which we provisionally label as *problem-focused methodological pluralism* (Dawson, Fischer, & Stein, 2006) and see best exemplified in terms of "research school" collaborations. On the

one hand, researchers and educators must facilitate the integration of diverse methods from different disciplines. It can be difficult to integrate and evaluate findings generated by radically different methods, such as methods in behavioral genetics geared towards heritability versus methods in psychology geared towards conceptual change. There are issues about how to bridge different *levels of analysis* and different *basic viewpoints* (Stein, Connell, & Gardner, in press). On the other hand, MBE demands *applied* research that directly addresses the needs of educators and students – which raises issues of how educators' expertise can shape research so that it can fruitfully create usable knowledge. Here we face the challenge of bringing complex interdisciplinary research into the worlds of educational policy and practice, which raises a host of practical concerns like relevance and effectiveness. These two broad problem areas – integration of diverse methods and connections to educational application (roughly aligned with the classical division of *theory* and *practice*) – point in the direction of a symbiosis between researchers and educators in the pursuit of usable knowledge.

Issues of quality control are generally agreed to be paramount in interdisciplinary work, often leading to arguments about validity and evidence (Gibbons et al, 1994; Klein, 1990). While disciplines have their own internal standards of quality control, interdisciplinary endeavors outstrip the practices of specific disciplines, raising new problems concerning what qualifies as valid and valuable work. MBE is no exception. Questions about what key *desiderata* might be for efforts in MBE stem partly from the applied nature of the field and partly from the wide range of disciplinary and practical concerns the field subsumes (Fischer, Immordino-Yang, & Waber, 2007).

With so many intersecting standards and goals, the criteria for what constitutes quality work in MBE are *more rigorous* than those found in single disciplines and in interdisciplinary fields that do not involve application. Specifically, depending upon the type of work, efforts in MBE must be scientifically valid, educationally relevant, and educationally effective, at least sometimes. These are demands that have faced educational research since William James (1899) published his *Talks to Teachers* at the turn of the last century, and the insight has been echoed by Dewey (1921) and Piaget (1965). The demanding nature of educational research as *applied* is not new.

What is new is the complex interdisciplinary matrix comprising MBE and the variety of pressing educational issues to be faced. The interdisciplinary matrix raises concerns about the scientific *validity* of claims made in the field. Interdisciplinary validity claims are complex epistemologically in so far as they implicate findings and methods from different *levels of analysis* (Stein, Connell, & Gardner, in press). For example, findings describing how genetic predispositions affect anatomical features at the level of the neuron can be related to findings from brain-imaging studies (such as functional magnetic resonance imaging, called fMRI) and ultimately to behavior on academic tasks. But each of these findings deals with phenomena at very different *levels of analysis*: genetic, neuronal, functional brain organization, behavior, and complex activities on academic tasks. Generally, levels-of-analysis issues arise when we attempt to bring findings and methods together that deal with phenomena of different scale and scope – spatially, temporally, or in terms of complexity. These kinds of issues are ubiquitous in MBE.

Orthogonal to level of analysis are issues having to do with differences of *basic viewpoint* (Stein, Connell, & Gardner, in press). Analyzing a student's classroom behaviors in terms of cognitive structures and then in terms of motivation and emotion involves taking up not different levels of analysis but different *basic viewpoints* on the same behavior at the same level of analysis. Levels of analysis are differentiated in term of the scale, scope, and complexity of the phenomenon being considered, so the difference between analyses of *behavior* and analyses of *brain function*s involves level of analysis. In contrast, when phenomena are at the same level, we can usefully analyze them in terms of different *basic viewpoints*, e.g. we can attempt to give an account of a classroom behavior either in terms of cognition or in terms of emotion (or some combination of the two). Likewise, the difference between *describing* the hyperactive behavior of a child and *evaluating* the worth of that behavior (e.g., "it's unacceptable," or "it's not anything to be alarmed about," etc.) is a difference of basic viewpoint, not of level. Generally, issues surrounding differences between basic viewpoints arise when we attempt to bridge methods and findings that presuppose different fundamental and deep-seated orientations toward what is being researched. The need to integrate and span multiple basic viewpoints pervades MBE.

A seductive temptation in building MBE is *reductionism* in analyzing phenomena that are studied at several levels of analysis or from different basic viewpoints. The tendency to offer unidimensional solutions to multidimensional problems is great – discussing a multi-level issue as if it can be reduced to one level or treating a multi-viewpoint issue as if one viewpoint is essential and the other can be omitted or neglected. For example, the press commonly presents findings from biological methods, such as

genetics and neuroscience, as if they involve "harder," more substantial, more scientific

knowledge – privileged relative to psychological and cultural methods, which are

marginalized as "soft," needing to be reduced to biological "causes". Counteracting this

tendency in MBE are the more direct connections of the behavior and culture to learning

and schools, captured in the withering critiques of reductionism that deflated the hubris of

logical positivism and its reductionist premises (Habermas, 1988; Piaget, 1971; Nagel,

1986; Sellars, 1963; Whitehead, 1925).

Moreover, the *problem-focused* nature of MBE precludes the undue

marginalization of ostensibly "softer" methods, such as those based on qualitative

analyses. The fMRI machine is very different from the classroom. What seems like a

valuable explanation in one place may seem hopelessly divorced from what is relevant in

the other. Educational issues involve values in shared cultural frameworks. Different

from the abstract problems of the laboratory, they necessarily enlist a wide variety of

methods, levels of analysis, and basic viewpoints.

This brings us to the other problem area shaping the trajectory of methodological

innovations in MBE: *the need to bring research into relation with educational practice

and policy*. Both the framing of educational problems and the implementation of

proposed solutions require the collaboration of educators and students with scientists.

With the improvement of educational practices as a stated goal, MBE cannot be a solely

scientific field. Most important educational issues are only resolvable in light of practice.

If we admit this, then we must admit that MBE is unlike strictly scientific fields, because

the progress of MBE is wedded to the progress of educational practices. And while this is

not the place to recount the challenges facing efforts at scientifically based policy reform

(Lagemann, 2000), it is clear that the standard conception in which scientists hand over their results from on high to educators in the trenches is not working. New collaborative relations are needed. Thus we suggest that progress in MBE requires a kind of symbiosis between educators and researchers capable of exercising quality control in the field – forms of cooperation that enable reciprocal feedback between educators and researchers to create usable knowledge and improve educational practice.

Importantly, this type of cooperative innovation, both institutional and methodological, places high demands on work in MBE, while it simultaneously provides a kind of practical quality control. It may be that conducting research in the context of practice is the best way to sort out the complex interdisciplinary and epistemological issues surrounding differences between levels of analysis and basic viewpoints. That is, we are suggesting that the validity of work in MBE is ultimately determined by a kind of *pragmatism*.

This is a theme we will return to when we discuss the *models* best suited to a field like MBE. The basic insight is that the purest usable knowledge entails a kind of openness toward different methodological approaches and traditions. With real tangible educational problems before us we cannot afford to unduly marginalize methods just because they are geared to certain levels of analysis or basic viewpoints. In the laboratory a good tactic is often to bracket certain perspectives in order to isolate factors and to clarify and simplify findings, but when connecting research with educational import requires framing it more broadly, making explicit connections to the perspectives relevant to practice. In light of a symbiosis between educators and scientists a broad approach toward complex interdisciplinary problems emerges, which is best characterized as

problem-focused methodological pluralism (Dawson, Fischer, and Stein, 2006; Stein,

Connell & Gardner, in press).

One potential embodiment of such an approach is the idea of a *research school*

(which Dewey, 1896, called a university school or a laboratory school), in which

research-based educational innovations are experimentally implemented, learned about,

re-tooled, and re-implemented by a community of educators and researchers working

closely together. According to this idea various researchers employing various methods

work to collaborate in a problem-focused manner with teachers and administrators to deal

with practical problems that are not pre-packaged for the laboratory, i.e. problems

spanning multiple levels of analysis in implicating a variety of basic viewpoints. In these

contexts the ultimate criterion of success is the improvement of educational practice that

results from an improved understanding of learning and teaching. Importantly, properly

established research school collaborations can also facilitate the proper handling of issues

surrounding *models* and *morality*, as we will explore below.

In addition, the establishment of communication channels, such as journals and

conferences, are important. MBE requires both the creation of a strong research

foundation for educational practice and at the same time clear, rigorous, and responsible

communication to a variety of audiences. Thus, in MBE more than mere scientific

acumen is needed for work to qualify as valid and valuable. Broad overarching concerns

about the future of educational practice serve to frame a problem-focused methodological

pluralism. This general structure of the field has implications for theoretical model

building, and it implicates MBE in moral issues concerning the means and ends of

educational institutions generally.

Models: Broad Frameworks for the Epigenetic System in Context

The problem-focused methodological pluralism that we have sketched for MBE sets certain directions for building explanations and theoretical models. With multiple methods and diverse kinds of results, the need for broadly integrative theoretical frameworks increases. Likewise, the needs to communicate to wide audiences and to affect practice entail the articulation, however provisional, of big-picture accounts of how the field hangs together. Specifically, MBE needs 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. These need to be models of *the epigenetic system as a whole and in context,* which draw upon diverse perspectives and findings while avoiding simplistic and reductionist accounts.

The work of Jean Piaget (1971, 1972) sets an important precedent here. As his ambitious research program in *genetic epistemology* unfolded across decades he offered a series of models involving explanatory constructs that cut across biological, psychological, and epistemological levels of analysis. The controversial specifics of Piaget's models need not concern us here (see Fischer & Bidell, 2006; Smith, 2002). What is relevant, and we think beyond dispute, is the value of his vision of *a comprehensive understanding of human developmental processes* (Rose & Fischer, 2009).

Some recent efforts in neo-Piagetian theorizing have kept Piaget's ambitions alive, updating his vision in light of recent research, while jettisoning some of his arguments that have not stood the test of time. Of particular note for MBE are efforts in

neuroconstructivism (Karmiloff-Smith, 2005; Mareschal et al, 2007), which offer models that subsume findings from neuroscience, genetics, and cognitive development. Such broad explanatory frameworks bring coherence to the unwieldy diversity of findings from diverse disciplines. These empirically grounded models reach beyond a single discipline or method and connect with a variety of audiences to frame educational issues and activities.

Fischer's *dynamic skill theory* is a related case in point (Fischer & Bidell, 2006). It aims to integrate the many influences on human behavior, counteracting the fragmentation of knowledge about human development that has come with the increasing differentiation and specialization of disciplines. By articulating constructs and methodological principles that cut across multiple levels of analysis, *skill theory* serves to frame the epigenetic system in its full complexity. The integration of methods from brain science, cognitive science, affective science, social analysis, dynamic systems modeling, qualitative structural analysis, and developmental assessment reveal human development as a dynamic process sensitive to contexts both biological and social. Research has revealed the educational relevance of this model and demonstrated that it can be operationalized in cycles of research and application in schools and other learning situations (Dawson & Stein, 2008).

Importantly, both the neuroconstructivist and dynamic skill theory frameworks involve general developmental principles that can make sense of *variability* and *individual differences*. These models frame learning disabilities, for example, in terms of the same explanatory principles that can account for typical development (for example, Schneps, Rose, & Fischer, 2007). The image that emerges is one in which *unique*

learning pathways unfold in terms of *ubiquitous* developmental processes. The ability of these models to account for diverse developmental trajectories sets them apart from many other models and makes them far more valuable in framing and integrating research for educational purposes. While Piaget (1970a, p. 52) admitted that his overall approach was not amenable to the understanding of individual differences, some others who offer developmental models with wide integrative ambitions (e.g. Tomasello 1999; Thompson, 2007) do not seem to feel the need to address variability and difference at all. It seems that when scholars build theories they often trade sensitivity to unique instances for broader scope and explanatory power, but that tradeoff is not necessary. As dynamic skill theory demonstrates, starting out with variability and individual differences can lead to principles that simultaneously (a) accommodate the messy reality of learning and development in real world contexts and (b) are *more* usefully abstract than typical psychological constructs (for example, the concepts and principles of dynamic systems theory).

A common critique is that such broad, abstract models cannot be disproved empirically. For example, Piaget's theory is criticized as too broad and vague. Nevertheless, it has generated a remarkable explosion of new research across many fields, much of it linked directly to educational research and practice (for example, Adey & Shayer, 1994; Griffin & Case, 1997). No doubt, such comprehensive models are not readily amenable to simple falsification. However, with pragmatic MBE criteria that emphasize both educational efficacy and scientific acumen, a model is subject to rigorous testing of both empirical predictions and practical usefulness (see Elgin, 2004). These broad models must pass the rigorous practical test of *creating usable knowledge*.

The emphasis on usable knowledge does not preclude basic research but instead requires including it as part of the field of MBE. The kinds of broad theoretical models of human development that are needed to frame MBE could not be built without a great deal of *strictly* theoretical and empirical work, such as neural-network modeling or fMRI paradigms. The point we are making about the fundamentally *pragmatic* criteria by which MBE models prove their worth bear on the models' implications, relevance, and efficacy for educational practice. That is, in MBE key problems are ultimately posed and solved in the world of educational practice. While basic research will always *contribute* to the solving of these problems – by informing broad theoretical models, for example – only research carried out in the context of practice and application will *explicitly address* the key problems of MBE.

Thus in MBE purely theoretical work in fields such as psychology and brain science needs to be re-framed and adapted from its place of origin – as answers to abstract academic problems – in order to address the concerns of educational practice. Generally, we think broad theoretical models geared toward practice can serve to integrate and frame a wide variety of theoretical findings and methods. This is demonstrated, for example, by dynamic skill theory, which assimilates and integrates work from various fields and research topics under general principles that address individual differences and real world variability and learning (Fischer & Bidell, 2006).

In other words, a symbiosis of theory and practice is needed to exercise quality control in problem-focused interdisciplinary fields such as MBE. Models are built for a purpose, and models in MBE must do more than yield explanations. The notion of a research school is helpful in grounding what it means for a model to generate usable

knowledge. In a research school, researchers and educators with different backgrounds

converge on a common educational problem space, where they craft a common language

to communicate, frame specific problems together, and articulate possible solutions. A

broad and comprehensive model of learning processes can facilitate this kind of common

language, e.g. here is what we mean by abstract thought, here is what we mean by

learning disability. Moreover, a broad model can provide a common *language of*

evaluation that is both scientifically rigorous and practically meaningful, illuminating the

reform of teaching practices through a broad framework for assessment and evaluation. A

good model will provide standards for evaluating student progress that are valid in the

eyes of both researchers and practitioners. Efforts underway using dynamic skill theory

demonstrate the power of such common standards (Dawson & Stein, 2008). Thus the

most valuable models in MBE will be those that can offer this kind of usable knowledge,

providing a comprehensive language and conceptual framework capable of helping to

align researchers and practitioners and translate between theory and practice.

As educators and researchers use broad, integrative frameworks to build problem-

focused models relevant to key educational questions, we need to consider how they can

be put to *good* use – issues of ethics and values that reach to the heart of MBE.

Morality: The Ends and Means of MBE

Moral issues figure prominently in debates about genetics, neuroscience, and

education because they relate to the nature of institutional structures and social norms

(Habermas, 2003). We cannot address all of this huge topic but will focus on issues

involving the symbiosis between theory and practice in MBE. Changes in educational

practice and the implementation of scientifically based interventions depend on moral

decisions – about goals and values for education and learning and the scope and nature of actions to achieve those goals. Generally, two complementary ethical themes are important. One concerns *limiting* the scope of certain possible scientifically based interventions in order to preserve the integrity and autonomy of individuals. *Not all knowledge that can be used ought to be*. The other theme concerns the *fair distribution* of benefits accruing from improvements of practice. *Knowledge that is put to good use should be used to help everyone*.

A long tradition of moral philosophy can be traced from Habermas and Rawls back through Dewey and ultimately to Kant, which maintains that the goals of our most important public institutions should be determined through processes of public will formation that are subject to continual revision. These goals, provisionally set by the community, serve to orient the use of new knowledge, insuring that the institutionalization of values proceeds dialectically, as science serves the ends that people set for themselves. Generally, MBE needs to position itself in broader value-laden discussions about the goals of education. It must find a way to address the moral considerations that emerge as its fund of usable knowledge expands.

There is a set of uncontroversial educational goals that garner nearly universal consensus in countries with democratic and post-industrial forms of government. Putting aside debates about character education and the unforeseeable skills needed for tomorrow's economy, few people dispute the value of literacy, numeracy, and a host of other basic capabilities. As MBE makes progress in creating new ways of affecting learning and development, important questions will arise about the kinds of things that people should do to foster these capabilities. Some of the kinds of questions are already

evident: Genetic screening and behavior modification through drugs are only the most obvious red flags in an ever-growing list of scientifically based techniques that can affect educational outcomes. There must be *limits* on the extent to which public goals can intrude upon people's private lives. Even projects aimed at fostering collectively held values such as education must stop short of transgressing the dignity and autonomy of individuals.

Following Habermas (1996) we believe that scientists and lawmakers cannot determine these limits alone. Ultimately, the voices of those potentially most affected by scientifically wrought changes in educational practice need to be heard. When it comes to issues of broad public concern (which pervade education) what is acceptable or not should never be decided *a priori* or in isolation from debates in the public sphere about the kinds of communities and individuals that ought to be fostered. Thus public forums are required that promote general discourse aimed at articulating the ethical limits that should be placed on use of biological and psychological technologies in education. Experts in MBE will have an important role to play in this discourse, but they will be one voice among many. In a world where the development and dissemination of science and technology proceeds at alarming rates, discourse about self-imposed limitations on these developments need to be accompanied by processes for codifying institutional policies and governmental laws. Building on reasoned public discourse, procedures must be established to enforce limits and principles for use of MBE tools and techniques.

Along with discourse about *limiting* the application of certain types of advances in MBE must come discourse about the *fair distribution* of potential benefits. Following Rawls (1971) we think that important issues about the *just* distribution of educational

goods will become central with advances in MBE. And these issues must be debated in light of their ethical significance, i.e. from the perspective of a universalistic moral point of view. There must be discourse and debate about how to make innovations widely available across racial, socio-economic, and international divides, involving discussion of both how valuable educational goods are (both for individuals and communities) and how generally *unjust* their distribution tends to be in most nations. This discourse in the public sphere needs to address laws and procedures for codifying policies and laws, including active steps to ensure that the advances and benefits of MBE will not be limited to improving the learning of a privileged few. The best education systems in the world (for example Finland) are characterized by their commitment to equality and fairness in the distribution of educational recourses (OECD, 2007). *Justice as fairness* should be a guiding principle in efforts toward scientifically based reformations of educational systems, making them both more equitable and more effective.

For both limitations and fair use of MBE knowledge, the broad community must participate in the debate. Scientists, philosophers, lawmakers, teachers, parents, and students must all weigh in. Too much is at stake for the conversation to be unduly truncated or limited to debates among elites. And so we return again to the need for symbiosis and dialogue among the stakeholders in this most important enterprise. A properly established research school could aid us in these efforts by mobilizing a diversity of voices to co-create educational environments. In such a research school the iterative process in which research-based educational innovations are experimentally implemented, learned about, re-tooled, and re-implemented can remain open at all crucial junctures to the input from the people most affected – students, teachers, and parents.

One format could be a series of structured town-hall meetings for a single school or school district where researchers, practitioners, students, and parents collaboratively frame the issues most essential to the betterment of their schools. Of course these miniature experiments in democracy will be rife with conflict and complexity, like democracy in general. The discourse can serve to inform institutional policies and practices, beginning a movement to create a culture concerned about both the ethics and the science of educational practice and capable of flowing upwards and outwards towards broader state and national policy.

Conclusion

The emerging field of Mind, Brain, and Education must be shaped not only by its constituent scientific disciplines but also by its applications to education and learning. The need for synthesis across scientific and practical disciplines points toward a problem-focused methodological pluralism and a catalytic symbiosis of theory, research, and practice. The goal of producing usable knowledge shapes the construction of theoretical models that provide holistic understanding, requiring comprehensive models of human learning and development that span multiple levels of analysis and multiple perspectives instead of a narrow focus on truth in a scientific discipline. Ultimately these models must be put to *good* use, creating usable knowledge the application and dissemination of which is shaped by moral considerations based on dialogue among all those potentially affected. The search for usable knowledge in MBE requires focusing on quality control in light of educational relevance and efficacy as well as scientific validity.

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