Growing Past Ourselves:
Toward a Pedagogy of Change through the Evolutionary Epistemology and Developmental Teleology of Charles Sanders Peirce

by

Sarah Elizabeth Cashmore

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy

Department of Social Justice Education
Ontario Institute for Studies in Education
University of Toronto

© Copyright 2017 Sarah Elizabeth Cashmore
Growing Past Ourselves: Toward a Pedagogy of Change through the Evolutionary Epistemology and Developmental Teleology of Charles Sanders Peirce

Sarah Elizabeth Cashmore

Doctor of Philosophy

Department of Social Justice Education

Ontario Institute for Studies in Education
University of Toronto

2017

ABSTRACT

Charles Sanders Peirce defends an approach to thought in which mind and inquiry are subject to ongoing evolution through the process of interpreting signs. This dissertation examines one often-overlooked element of Peirce’s semiotics, the role of evolutionary chance, in the growth and development of ideas. Further, it contrasts his evolutionary approach with the computational framework that is common in educational representations of learning used today.

The Ontario Ministry of Education promotes “student-centred” teaching strategies, which are said to be tailored to the needs of diverse students. One such popular approach, Differentiated Instruction (DI), derives at least part of its understanding of intellectual diversity from Howard Gardner’s intelligence framework, Multiple Intelligence (MI) theory. MI theory suggests that intelligence is segmented into several distinct and universal computational modalities. However, studies in evolutionary biology support Peirce’s more reflexive principles that intelligence does not reside in the brain as MI theory suggests, but is a process that occurs through the interrelation between an organism and its environment. This approach suggests that intelligence is highly individualized and subject to ongoing change and evolution. A challenge is presented that
intelligence is more personal and less universal than the MI account allows, and further points to the limitation of certain kinds of research questions to account for the interconnectivity and individualism of ongoing evolution.

In suggesting an inquiry framework in which ongoing evolution is acknowledged, I turn to the work of Charles Sanders Peirce. Specifically, I look at his conception of the role of chance to defend an epistemology and teleology wherein living beings are not seen as growing along a fixed trajectory but pursue ends that change as they do. In light of this alternative evolutionary framework, teachers and researchers may change their role from one of mere stewardship, carrying students from one stage of understanding to the next in predetermined paths, to one of celebration, where student growth is fostered tentatively and in anticipation of new forms of knowledge that may be encountered in the classroom.
ACKNOWLEDGEMENTS

No seed grows into fruit on its own, but relies on the nourishment and light of its environment to eventually find its fullest expression. So too have I, and this project, grown in the light and love of family and friends, both old and new. For that reason, I feel I share this achievement with everyone who has walked beside me. I will never be able to express how this work was propelled forward, and shaped, by sometimes the tiniest word, encouragement, or suggestion. My family, friends, and mentors have not just interacted with this work, but are truly reflected in it.

I would like to extend my sincerest gratitude to my thesis advisor, Dr. Eric Bredo, who has been such a kind and gracious mentor to me. Eric, thank you for your good-natured patience while I found my academic voice.

I would like to extend my sincere thanks to the rest of my dissertation committee: Dr. Lauren Bialystok, Dr. John Portelli, Dr. Megan Boler, Dr. Peter Trifonas, and Dr. Jim Garrison. Your rigorous assessments and insightful suggestions improved the quality of my dissertation immensely. I look forward to the future of my research efforts in large part because of the support, direction, and encouragement you have provided.

This project also would not have been possible without the support and encouragement of my family and friends. I am especially indebted to my parents, Linda Becker, Len Cashmore, and Sue Penner-Cashmore, and my siblings Jessica, Annika, Max, Caleb, and Crystal for their unwavering love and enthusiastic encouragement. A special thanks to Uncle Henry (B.L.U.E.) and Aunt Chris, my own personal cheering squad! Corrine LaPlante, your positivity has always shone bright like a star! Thank you for ever lighting my path!
Special gratitude goes to the many colleagues I have learned and worked with over these past years. In particular, I would like to thank the following people for their support, conversation, and insight, which shaped my doctoral experience to become more than I ever imagined: Ramsey Affifi, Selena Nemorin, Scott Balasak, Paul Grouchy, Kevin Naimi, Shadi Afshar Kharaghan, Trevor Norris, Brad Rowe, Liz Coulson, Angela Vemić, Denis Walsh, Daniel Brunson, Vincent Colapietro, Walter Okshevsky, Christopher Martin, Chris Hables Gray, Judy Village (a lucky chance encounter!), and Dan and Katherine Becker. I would also like to acknowledge staff at OISE and University of Toronto, without whom my thesis would not be possible at all; many thanks to Karen Dinsdale, Sezen Atacan, Kristine Pearson, David Eden, Susan Hall, and Lise Watson. Extending much gratitude to all my colleagues at Lakehead University and Niagara University; working with you has been both an honour and a delight! I would also like to extend special appreciation to Bob, Maeve, and Greg Hughes, who adopted me as one of their own and have been unwavering in their support.

And last, a heartfelt thank you to my own little family. To the best partner a girl could hope for, Timothy Hughes, you’ve carried so much of this burden with me, and this thesis would not have been possible without your love, support, and sacrifice. These pages are infused with the joy you bring to my life. Thank you for taking such good care of me and all our plants and animals. I can’t wait to see what the next chapter of life brings us!
# TABLE OF CONTENTS

**Introduction**  
1. Diversity as a key value in Ontario education  
   1.1. Student-centred learning as an approach to inclusive education  
   1.2. Sources of pluralism in Differentiated Instruction: Multiple Intelligence theory  
2. The theory of Multiple Intelligences: Framework and limitations  
   2.1. The classification of intelligence  
      2.1.1. The biological-psychological approach  
      2.1.2. The role of culture  
   2.2. The growth of intelligence  
      2.2.1. Developmental flexibility  
      2.2.2. Growth through social learning  
   2.3. Framework limitations  
      2.3.1. The conflicting role of culture  
      2.3.2. The epistemological and teleological limits of science  
   2.4. Discussion directions  
      2.4.1. Contingency in development  
      2.4.2. "Unfinishedness" in science  
   2.5. A statement on approach  
3. In search of an evolutionary account of mind: Charles Sanders Peirce  
   3.1. Review of literature  
   3.2. Peircean epistemology: A counter to the classical position
3.3. Reciprocal constitution through semiotics 89
3.4. How to be an antifoundationalist without being a relativist 97

4. Peirce’s evolutionary theory of growth 101
   4.1. The definition of chance 103
   4.2. The role of chance in the study of mind 114
   4.3. Implications of a developmental teleology for the sciences 118

5. Implications for educational theory 124
   5.1. Epilogue 124
   5.2. Implications for the sciences 132
   5.3. Implications for educators 135

References 142
To Matthew, Madison, Kennedy,

Lily and Madeline

For who you are

and who you will become
Love is not love which alters when it alteration finds.

-- Shakespeare, Sonnet 116

The movement of love is circular,
at one and the same impulse projecting creations into independency
and drawing them into harmony.

-- Charles Sanders Peirce, Evolutionary Love
INTRODUCTION

In an ongoing effort towards the best possible educational methods, a current trend in North American pedagogy is the belief that teaching and learning practices can and should be tailored to each individual student, an approach often called student-centred instruction. From one perspective, tailoring education to individual students’ needs is the crowning achievement of modern schooling and research. The very effort to try to understand our children so well that we can appropriately shape their learning experiences seems to be the pinnacle of student care. But from another perspective, such an endeavour may be loaded with hubris. The supposition that we can fully understand another being and determine its needs carries hidden assumptions about the quest, and achievement, of human knowledge. That such assumptions remain hidden speaks to how the underpinnings of these efforts have been overlooked. It has been left unsaid, and unquestioned, how we reached these educational goals at all. Through an examination of its expectations, I hope to shed more light on how learning tends to be conceived in education, how individual differences are conceived, and what the unexamined consequences are of approaching diversity in this way.

In one sense, this thesis is about diversity. Educational research suggests that each child is unique, but how do we know that? What does our individual difference mean to us? Answers to such questions require reaching deep into our assumptions about not just what makes us different, but in what ways we are the same. Being a discipline that serves a singular function in human beings—learning—education is wrought with some level of essentialism. Humans are assumed to have certain fundamental qualities that are more similar than the things that make us different. Such is the basis of many current
approaches to student-centred instruction. In other words, it is suggested that we have developed our individual characteristics within other characteristics that have remained the same.

While much of this conversation is about diversity, it is also about development. Yet development, too, is a contested notion. This thesis attempts to compare the concept of ‘development’ between psychology and evolutionary studies. The implications for education are significant. Educational concepts, principles, and strategies are often borne from psychological studies (often from its own branch, educational psychology). Traditionally, the field of psychology is concerned with processes and stages of development over the course of a lifetime. Typically, it sees the progression of development as a linear stage theory (Phillips & Kelly, 1975), from a person’s beginnings in infancy to her completion in the fully mature adult. Evolutionary studies, on the other hand, looks at how species can change (or have changed) over time by adapting to their environments. Herein lies the challenge. Educational studies, by drawing its understanding of development exclusively from psychology, tends to look at how a person matures over their lifetime and is typically concerned with how teaching and learning environments can be tailored to fit within this linear progression. However, from a perspective informed by evolutionary studies, education is seen as overlooking how that progression itself changes over time.

It would seem that education would benefit from incorporating insights from both fields. But how to do so becomes unclear; the linear metaphors and principles of psychology can, and often do, conflict with the more open-ended processual metaphors of evolutionary studies. The solution I propose involves changing how we depict, and think
about, human minds. This will entail letting go of certain linear computational metaphors common to psychology, in place of more processual accounts of evolution and adaption, while maintaining use of other insights from psychology.

In an attempt to lay out this issue, I have framed this conversation as an investigation into the concept of diversity as it is presented in the pedagogical standards of the Ontario Ministry of Education. The first chapter of this discussion is an in-depth look at this concept. I outline the teaching standards and recommendations provided in the Ministry of Education’s pedagogical guide to teaching for student diversity. Through this investigation, I show that Differentiated Instruction is Ontario’s prime teaching strategy for student-centred instruction. Further, I show that the theory of mind that undergirds Differentiated Instruction is drawn primarily from Howard Gardner’s theory of Multiple Intelligences (MI), a theory of mind developed in the 1980s that remains a popular model today. MI theory suggests that intelligence is segmented into several distinct and universal computational modalities. Through this model, diversity is seen as being a person’s unique combination of universal traits that all humans carry to some extent. Educational policy makers have adopted this model enthusiastically, instantiating student-centred practice informed by MI theory in teaching standards across Canada and the United States. They stress that the success of educational interventions relies on knowledge of these intelligences. I close this chapter with an explanation of my intent to investigate the MI model to uncover its hidden assumptions and the implications of thinking about minds in this way.

In the second chapter, I investigate Gardner’s explanation and justification of his Multiple Intelligence model of mind and raise two challenges to his theory. Gardner
justifies his model by recourse to biological ‘canalization,’ the process by which distinct neural pathways evolved into separate and largely autonomous cognitive systems. A section of this chapter is dedicated to exploring how this process is evident across the animal kingdom. These systems, Gardner argues, are partitioned according to the kinds of functions they support, and as such he likens these ‘intelligences’ to computational mechanisms. Society helps draw out these intelligences, he explains, by offering outlets for their expression, but the plan for the growth of these intelligences resides in the genome. By positing that human intelligences can be defined independently of social ends but then are interpreted in the light of social ends, Gardner has inadvertently locked himself into a paradox. He has made contradictory claims wherein intelligences can be defined independently of social ends yet have their meaning in terms of social ends. Beyond this paradox, Gardner has also positioned himself in a dualism of internal versus external functions, wherein the discrete, innate computational functions of the intelligences are separate yet connected, affected yet not affected, by an individual’s external conditions.

This sets the stage for two challenges raised in the second half of this chapter. First, studies in evolutionary biology suggest that we do not simply ‘interact’ with our environments with internal processing systems that are fixed and discrete (such as different intelligences), but rather that what we perceive of the world is filtered through mere habits of meaning and access that can themselves be altered as a result of our transactions. Such a challenge undercuts Gardner’s computational representation because living beings respond to changes in ways that computers can’t. By this ‘transactional’ model, there is limited value in differentiating between the contributions of the ‘internal’
and ‘external’ worlds, because each shapes and defines the other. The ongoing diversification that is central to a transactional model sets the stage for a second challenge to Gardner, which questions the role of science and its ability to provide a comprehensive account of mind. Gardner presents his work as a quest for the governing principles of human intelligence. However, the comprehensive account of mind that Gardner claims to have found is seen as an inappropriate goal when juxtaposed with the individualized evolutionary trajectory provided by the extended evolutionary approach mentioned above. These two challenges, taken together, provide direction for the remainder of the discussion: first, how science and education can account for ongoing diversification in nature, and, second, how science and education can adapt with its evolving subjects.

In Chapter Three, I introduce a possible framework to account for diversification and development, borrowed from the philosophy of Charles Sanders Peirce. As one of the first philosophers to be influenced by Darwin, he embedded the concepts of change and flux into his theory of inquiry. The defining feature of Peirce’s philosophy is his semiotic approach to inquiry, in which beliefs are habits of interpretation that are evaluated according to their ability to cause or assuage practical hesitation or doubt. For Peirce, truth is an ideal, a claim that will never raise doubt. By relying on a system of inference and interpretation that seeks to eliminate doubt rather than simply compile knowledge, Peirce provides a framework that meets the criteria sought above: it allows for the ongoing evolution of nature, while providing an account of knowledge that can adapt along with it.

In Chapter Four, I explore how evolutionary change can fit within a conceptual structure that claims to be scientific. Traditional accounts of science, including Gardner’s,
rely on mechanistic and deterministic regularity for their explanations. Change is
typically seen as an aberration or ‘swerve’ from that regularity. However, Peirce’s
account of habits provides a useful framework for accounting for change. If universal
laws can themselves be seen as habits of interaction, it allows for the inclusion of chance
encounters to be the origin of those habits. Peirce describes coincidental or spontaneous
events as a “germ” after which there is a greater probability that a pattern of that germ
will develop (1887-88, p. 277). A habit strengthened enough, Peirce argues, could
eventually regulate the actions of other things, which we would define as a natural law. In
other words, rather than suggesting that out of law some element of chance exists, Peirce
suggests that out of chance some element of law forms. Seen this way, mechanistic
determinism is not the sole causal factor in nature, but rather is exaggerated in its
importance. The combination and interrelation of chance and law form the basis of
Peirce’s evolutionary approach to knowledge and being, an approach he calls a
‘developmental teleology.’ I utilize this view in my recommendations for educators,
formulating a position I call a pedagogy of change.

In Chapter Five, I draw out the implications of an extended evolutionary
framework for scientists and educators alike. To researchers, I suggest that finite theories
of human intelligence, such as that proposed by Gardner, serve us poorly by enclosing
human beings and their minds in static, universal frameworks rather than nurturing
novelty or active engagement that may create new forms of thinking and understanding.
Such supposedly universal knowledge risks leading to dysfunctional behaviour as we, in
our attempt to meet the needs of diverse learners, risk becoming dogmatic in what those
diverse needs are. To educators, I suggest that a pedagogy of change may transform
teachers’ role from one of mere stewardship—where they carry students from one stage of understanding to the next in predetermined paths—to one of celebration—where student growth is fostered tentatively and in anticipation of new forms of knowledge that may be encountered in the classroom. This entails what Peirce calls evolutionary love, an approach where one fosters growth as best as she understands it, tempered with an understanding that chance might inspire a new or novel situation she can’t understand.

Thus, I argue that in addition to calling for a renewed philosophy of inquiry, Peirce’s semiotic approach to evolution calls for a renewed philosophy of education, a pedagogy that accounts for change.
CHAPTER 1 – Diversity as a Key Value in Ontario Education

In 2009, the Ontario Ministry of Education redoubled its efforts to address equity in the classroom, stating one of the primary goals of its new term as “embracing diversity and moving beyond tolerance to acceptance and respect” (Ontario Ministry of Education, 2009, p. 2). According to its report on equity and inclusion, Ontario is home to over half of the 1.1 million newcomers to Canada, with Ontarians reporting more than 200 languages as their mother tongue (and the proportion of Ontarians reporting English as their mother tongue on the decline) and representing over half of Canada’s visible minorities¹. The number of identified same-sex couples has also increased by 40% during this time. With this level of demographic change, it may come as no surprise that the topic of diversity in the classroom is currently a predominant conversation point for teachers, administrators, and policy makers alike.

At the level of policy, the Ministry of Education has defined diversity as follows:

The presence of a wide range of human qualities and attributes within a group, organization, or society. The dimensions of diversity include, but are not limited to, ancestry, culture, ethnicity, gender, gender identity, language, physical and intellectual ability, race, religion, sex, sexual orientation, and socio-economic status. (Ontario Ministry of Education, n.d., p. 2)

¹ These numbers are based on the 2006 Canadian census and represent totals between 2001-2006. More current statistics were not available at the time of writing. Current statistics on the present state of disability and accommodation diversity were also not available at the time of writing.
Accommodating diversity is internationally recognized as a critical component of high-quality education (UNESCO, 2008, p. 5, in Ontario, n.d., p. 2). The attempt to address diversity through educational means is known as inclusive education, the definition of which encompasses both the individual student and her environment:

Education that is based on the principles of acceptance and inclusion of all students. Students see themselves as reflected in their curriculum, their physical surroundings and the broader environment, in which diversity is honoured and all individuals are respected. (Ontario, n.d., p. 2)

To this end, an amendment was made to the Education Act in 2012 (Bill 13), which set expectations for all school boards to provide safe, inclusive, and accepting learning environments. Under these mandates, students are to see themselves reflected in their curriculum and learning environments because “rejection, exclusion, and estrangement are associated with behaviour problems in the classroom, lower interest in school, lower student achievement, and higher dropout rates” (Osterman, 2000, pp. 323-367; in Ontario, 2009, p. 9).

As part of the effort to support this new bill, the Ministry of Education provided administrators with a range of educational resources relating to diversity, including focused professional development on diversity training, networks that allowed educators to share effective practices, resources such as the Equity and Inclusive Education (EIE) Implementation Networks, and policies and guidelines to support student achievement.
and well-being. The Ministry of Education also released a report entitled *Ontario’s Equity and Inclusive Education Strategy*, which “aims to help the education community identify and address discriminatory biases and systemic barriers in order to support the achievement and well-being of all students” (Ontario, n.d., p. 1).

1.1. **Student-Centred Learning as an Approach to Inclusive Education**

In addition to these provincial and school initiatives, the Ministry developed resources for public school teachers to help them learn about principles and strategies of inclusive education. A key guide is the 2013 publication *Learning For All*, a guide to effective student-centred instruction and assessment techniques for students from kindergarten to Grade 12. This guide promotes two specific approaches to instruction, both of which are intended to “[respond] to the characteristics of a diverse group of students” (Ontario, 2013, p. 12). One recommended approach, known as Universal Design for Learning (UDL), provides broad principles for planning learning environments that accommodate the widest possible range of learning needs. Adapted from architecture studies, the theory behind this approach states that environmental accommodations for specific learning needs (such as wide desk aisles for students who use a wheelchair), can be beneficial for other students as well (wider aisles mean more freedom for all children to move and explore). “Universal design accommodates people with disabilities, older people, children, and others who are non-average, in a way that benefits all users” (OWP/P Architects, VS Furniture, & Bruce Mau Design, 2010, p. 200, in Ontario, 2013, p. 13).
Whereas UDL addresses broader concerns in designing lessons and learning environments, the other recommended approach, Differentiated Instruction (DI), focuses on addressing individual students’ specific learning skills and difficulties (Ontario, 2013, p. 12). Differentiated teaching occurs when instruction is adapted to students’ individual characteristics in learning, including differing strengths, interests, learning styles, and readiness to learn (Ontario, 2013, p. 17). Carol Ann Tomlinson, widely considered the foremost proponent of this strategy (Baldwin, 2010), identifies three areas in a lesson that can be differentiated to accommodate learners: the content of a lesson, or what students are going to learn, the process by which students learn the lesson, and the product students deliver to demonstrate their learning (Tomlinson, 1999). For example, differentiation might look like a teacher adjusting the number of learning goals a student must engage compared to the rest of her classmates (content), choosing specific student grouping for a particular task or project (process), or allowing a student to give an oral presentation if she is unable or unready to write in long form (product).

These two strategies, UDL and DI, promise to “enable educators to respond to the strengths and needs of all students” in a way that is “precisely tailored to the unique strengths and needs of each student” (Ontario, 2013, p. 12). These approaches credit their potential success to a personalized learning experience, fostered by strong understanding between teacher and student.

All these approaches help improve student achievement because they rely on greater personalization and precision in instruction. Their success depends on educators’ clear understanding of their students’ strengths and needs, the
types of learners they are, their readiness to learn in a given subject at a given time, and the kinds of learning tasks that are likely to engage their interest and stimulate their thinking. (Ontario, 2013, p. 13)

These strategies, which may be considered forms of student-centred pedagogy, serve to move educators away from one universal instructional approach to a more specialized approach that takes individual idiosyncrasies into account (Ontario, 2005, p. 14). This is not exclusive to Ontario, but is a dominant theme in elementary education policy in Canada and the United States. In addition to DI and UDL, other strategies that fall under this trend toward individualized education include Understanding by Design (UbD) (also known as ‘backwards planning’), authentic assessment, and brain-based education (also known as ‘neuroeducation’).

One way to understand individualized instruction is to investigate the account of enhanced learning and learning styles suggested by its proponents. Many principles of student centred learning, including DI, have been pieced together from various parts of psychology, such as developmental psychology and neuroscience. Thus, the characteristics attributed to student minds and learning are influenced by the traditions, values, and goals of these sciences.

1.2. Sources of Pluralism in Differentiated Instruction: Multiple Intelligence Theory

Differentiated Instruction originated out of a desire to tailor instruction to the strengths and needs of each student; “Its primary goal is ensuring that teachers focus on processes and procedures that ensure effective learning for varied individuals”
(Tomlinson & McTighe, 2006, p 3). Tomlinson attempts to justify her suggestions for how teachers should teach by correlating them with research in the study of intelligence.

DI and other student-centred approaches to instruction, including UbD and authentic assessment, borrow heavily from a particular theory of mind meant to account for diversity in learning needs – Howard Gardner’s theory of Multiple Intelligences (MI). Gardner’s theory was attractive because it, too, challenged a one-size-fits-all approach to thinking and learning. Initially developed out of dissatisfaction with the one-dimensional conception of intelligence popular in the early-to-mid 20th century, Alfred Binet’s IQ or Intelligence Quotient test, and its standard use in school testing, MI theory argued that the IQ framework did not account for the full range of mental capacity a person expressed over the course of her life. In *Frames of Mind*, Gardner’s first introduction to MI theory, Gardner argues that intelligence is not a singular entity, as conceived in traditional IQ testing, but, rather, is multidimensional. By this he means that the process of thought is comprised of distinct yet interrelated modalities. These modalities have distinct biological locations in our brains and are utilized differently according to varying circumstances. Through the process of evolution, he argues, we have developed separate yet related “intellectual competences” (Gardner, 1983, p. 8), which are neuronally-structured modes of meaning-making, symbolizing, problem solving, and creative problem finding (Gardner, 1983, p. 24).

---

2 Gardner was not the only psychologist at the time arguing for a wider understanding of human intelligence at the time; he was one of a number of 20th century psychologists who attempted to infuse psychology with a more socially-oriented understanding of the human being. Early theorists who acknowledged intellect as constructions between social agents included Pestalozzi (1801), Dewey (1916), Vygotsky (1927), and Mead (1934). Building on the paradigm shift triggered by these thinkers, his contemporaries in psychology (including educational psychology) developed this idea further, in the work of Bruner (Wood, Bruner, & Ross, 1976), Bronfenbrenner (1979), Lave (1988), and Csikszentmihalyi (Csikszentmihalyi & Rathunde, 1998).
Gardner abbreviated “intellectual competences” to simply *intelligences*. These intelligences help individuals become meaningful players in their society, and are fostered according to how relevant or valued a part those intelligences play in that society (1983, p. 26). Gardner never settled on an exact number of intelligences, as he claimed it is the nature of scientific investigation to adjust conclusions as evidence continues to come in (1983, p. 59), but initially identified seven; in 1995, Gardner added an eighth intelligence (1995a), which is the number adopted by the Ontario curriculum documents: verbal/linguistic, visual/spatial, logical/mathematical, bodily/kinesthetic, musical/rhythmic, interpersonal, intrapersonal, and naturalist (Ontario, 2013, p. 18).

It is claimed that, as a species, human beings have evolved over the millennia to carry out at least these seven forms of thinking. In a biological metaphor, these may be thought of as different mental ‘organs’ (Chomsky, 1980); in a computational metaphor, these may be construed as separate information-processing devices (Fodor, 1983). Although all humans exhibit the range of intelligences, individuals differ—presumably for both hereditary and environmental reasons—in their current profile of intelligences. (Gardner & Hatch, 1989, p. 5)

Authentic assessment, according to Gardner, consists of modes of learning and evaluation that allow each student to demonstrate his or her range of intellectual strengths, what Gardner calls “intelligence-fair measures” (Gardner & Hatch, 1989, p. 6). Gardner promised a richer and more authentic mode of assessment if multiple intelligences were
incorporated into the education system, because using a more comprehensive account of intelligence would allow more personalized instruction (Gardner & Hatch, 1989). For example, rather than treating students on a linear scale of intellectual level, as in the IQ test (which is usually based on verbal/linguistic and mathematical/logical levels, or their sum), one could treat students in accordance with a profile of competencies (intelligences); “Although these two forms [verbal-linguistic and logical-mathematical] are obviously important in a scholastic setting, other varieties of symbol use also figure prominently in human cognitive activity within and especially outside of school” (Gardner & Hatch, 1989, p. 5). Thus, the educational value of MI theory “lies in its potential contributions to educational reform,” but in order for it to do so, “progress seems to revolve around assessment” (Gardner & Hatch, 1989, p. 6).

Educational practitioners of Differentiated Instruction have run with this, promoting Gardner’s intelligences as a guide for modifying the content, process, and products of learning experiences. Specifically, Tomlinson points to Gardner’s research to demonstrate that “intelligence is multifaceted, not a single thing” (Tomlinson, 1999, p. 18), and suggests we use this research to inform our educational interventions. She suggests that the educational materials in a learning environment must match the skills and talents of the students within that learning environment. Drawing on Gardner’s approach, she states, “development of our potential is affected by the match between what we learn and how we learn with our particular intelligences” (Tomlinson, 1999, p. 18). In other words, since we think, learn, and create in different ways, our lesson materials and the modes of our assessment should be similarly differentiated. This is why Tomlinson calls for flexibility in the content, process, and product of instructional
goals—so that a person can demonstrate their knowledge and understanding in a way in which they can excel the most\(^3\).

These tailored interventions are made to appear urgent and imperative to the quality of education. As Tomlinson argues, “providing children with rich learning experiences can amplify their intelligence, and denying them such richness of experience can diminish their intelligence” (Tomlinson, 1999, p. 18). The notion that intelligence is subject to development is drawn from Gardner’s work, which suggests that biological sciences ought to help us determine educational interventions (Gardner, 1983, p. 31-32); “Provision of this variety of ‘high-affordance’ materials allows children to gain experiences that engage their several intelligences, even as teachers have the chance unobtrusively to observe and assess children’s strengths, interests, and proclivities” (Gardner & Hatch, 1989, p. 7). Otherwise, our students’ aspirations are said to be at stake: “Tying the activities to inviting pursuits enables students to discover and develop abilities that in turn increase their chances of experiencing a sense of engagement and of achieving some success in their society” (Gardner & Hatch, 1989, p. 7).

Gardner stated that if the source and nature of intelligence could be revealed, it would “be possible to determine which educational interventions are most effective in allowing individuals to achieve their full intellectual potentials” (Gardner, 1983, p. 32). The Ontario Ministry of Education embraced Gardner’s results with enthusiasm, as noted in a government-issued instructional guide on literacy:

---

\(^3\) In recent years, Tomlinson has attempted to further bolster her claims by collaborating with a neuroscientist to present neuron-level evidence of the value of her guiding principles for educators, in addition to Gardner’s modal approach (see Tomlinson & Sousa, 2011).
Being aware of all eight forms of intelligence enables teachers to plan activities that build on the strengths of each student and that help students to develop their intelligences in areas that are not naturally strong. It is important for teachers to vary their approaches and class work to ensure that students grow in all eight areas. (Ontario, 2006a, p. 22)

Another volume in this series frames the importance of Gardner’s theory in terms of motivation and student self-esteem:

Student self-esteem is fostered through the creation of competencies. Helping students to develop competencies empowers them and creates an intrinsic motivation to learn. Success in supporting student learning depends, in part, on taking into account the diversity of learning styles among students in the classroom. (Ontario, 2006b, p. 4, emphasis in original)\(^4\)

Note that a sense of conclusion and categorical understanding is present in their description of its use: “When teachers take these intelligences into account in their lesson design and their assessment of student achievement, they can focus on a range of student strengths that reflects the varied abilities of the class as a whole” (Ontario, 2006b, p. 4, emphasis added).

\(^4\) It should be noted that addressing Gardner’s theory as one of “learning styles” is a common misnomer, one that Gardner himself tried to correct. To Gardner, the intelligences refer to the computational faculties one uses to solve problems, whereas a learning style refers to a hypothesis about how an individual approaches new materials (2013).
To summarize, the Ontario Ministry of Education supports and actively promotes a picture of the learning individual that is lifted from Gardner’s theory of Multiple Intelligences and a student-centred pedagogy that strives to ascertain and meet the learning needs of a spectrum of students:

In addressing the potential of all learners, it may be important to identify which intelligences dominate and to assist students in utilizing their areas of strength for learning and in developing areas that require improvement. Teachers can do this by presenting lessons that include multi-modal presentation – singing, performing, building, interacting with an audience, displaying charts and diagrams – and providing opportunities for reflection and cooperative and leadership skill development. Gardner also stresses that each of us has our own developmental sequence of learning, and these sequences emerge at different times in our lives. Learning environments can be designed to support the learning potential and creative expression of each student. (Ontario, 2002, p. 122)

Differentiating instruction in this way is said to “increase the likelihood that any given lesson or project is highly engaging and personally meaningful for each student” (Ontario, 2013, p. 18).

Curriculum tells teachers what to teach, while differentiated instruction tells teachers how to teach it to a range of learners by employing a variety of
teaching approaches. Students can develop their potential if they are provided with appropriate activities in an environment that is planned and organized to meet the needs of all learners. (Ontario, 2005, p. 14)

It is noteworthy that the impetus for educational change to accommodate diversity, and the strategies recommended to this end, entail a promise to meet the needs of every student. The Ministry of Education uses a quote from Canadian educator and antiracism and equity advocate, George Dei, for their battle cry: “Inclusion is not bringing people into what already exists; it is making a new space, a better space for everyone” (Ontario, 2009, p. 2). Personalized instruction, which opens up freedom of expression and learning for each child, is obviously the goal, but this ideal raises questions about what this means and how one can accomplish it. In what follows, I will investigate the claims, values, and goals surrounding individualized student instruction as a method for accommodating diversity. As mentioned, DI, the approach recommended for this purpose, is actively promoted by the Ministry through training and resources that help teachers “enhance learning by taking account of students’ particular learning styles and circumstances…establishing conditions that recognize diversity, promote inclusive education, and support equity in our schools” (Ontario, 2009, p. 14-15). Through an examination of its expectations, I hope to shed more light on how learning is conceived, how individual differences are conceived, and what the unexamined consequences are of approaching diversity in this way.
CHAPTER 2 – The Theory of Multiple Intelligences: Framework and Limitations

One way to understand the assumptions behind the claims of personalized instruction is by investigating how Gardner reached his findings. In doing so, we will discuss the description of the multiple intelligences, as Gardner outlined them, in terms of their *identity* and *flexibility*; “A comprehensive science of life must account for the nature, as well as the variety, of human intellectual competences” (1983, p. 31). Discussing the purported source and character of the intelligences will provide us a definition of intelligence, and an explanation of the parts and processes involved. Examining flexibility will allow us to consider Gardner’s conception of growth or development. These are not completely separate discussions, however, as each concept informs the other, and will thus be visited in concert.

2.1. The Classification of Intelligence

In his study, Gardner utilized samples from as varied a set of populations as possible in an attempt to document the full nature and variety of human cognition (Gardner, 1983, p. 36). He further attempted to inform his theory by a deep knowledge of the nervous system (1983, p. 30), based on a review of common approaches to intelligence, such as cognitive and behavioral studies, as well as “outliers,” such as remote civilizations, case reports on accidents, case studies of labeled geniuses, and even animal studies. In short, Gardner sought as comprehensive an understanding of human potential as possible. Only in this way, he reasoned, could he provide “optimal” results (1983, p. 30).
Previous conceptions of mind, Gardner argues, especially those supported by traditional IQ studies, present intelligence as an overarching capability that underlies every possible cognitive process. This view of intelligence as a unitary capacity that can be all things for all kinds of thought, Gardner terms horizontal⁵. But, he argues that such theories overlook key elements of the human story:

As we have seen, the I.Q., the Piagetian, and the information-processing approaches all focus on a certain kind of logical or linguistic problem solving; all ignore biology; all fail to come to grips with the higher levels of creativity; and all are insensitive to the range of roles highlighted in human society. Consequently, these facts have engendered an alternative point of view that focuses precisely upon these neglected areas. (1983, p. 24)

According to Gardner, one significant problem with the IQ model of intelligence, and any other approach that sees the brain as a horizontal information-processor, was that it was “studiously non- (if not anti-) biological” because it did not connect with what was known about the nervous system (Gardner, 1983, p. 23). Gardner argued that his approach was distinguished by being more in touch with human development in relation to the nervous system (Egan, 2003). A second problem was that previous accounts of intelligence had little interest in creative problem solving and problem finding. Of IQ tests he says, “The problems posted characteristically feature a single solution or small

---

⁵ He points to Jean Piaget as an educational theorist who succumbs to a horizontal theory of mind (1983, p. 27).
set of solutions, and there is scant attention to problems with an indefinite range of solutions, let alone the generation of new problems” (1983, p. 24).

Thus, Gardner defines his investigation as focusing on “symbol systems,” or ways of meaning-making. He states, “The challenge, as we see it, is to compose a developmental portrait of each of these forms of symbolic competence and to determine empirically which connections or distinctions might obtain between them” (1983, p. 26).

Gardner presented his theory as an attempt to marry biological and psychological specifications that addressed each of these components (Gardner, 1983, p. 62). In doing so, he would “[stretch] the word intelligence beyond its customary application” (Gardner & Hatch, 1989, p. 5).

2.1.1. The biological-psychological approach

Having reviewed various potential conceptions of intelligence, including those deriving from genetic, cognitive, biological and psychological sciences, Gardner finds each approach to be lacking sufficient descriptive power for a well-rounded theory of intelligence (see Gardner, 1983, Chapter 2). However, in concert, he argues, the biological and psychological approaches can tell us not only what is happening in the mind, but why. Therefore, Gardner adopts what he calls a “biological-psychological basis” to his study of mind.

In contrast with the horizontal theories of intelligence, Gardner argues that there appear to be cognitive systems that act in considerable independence from one another,

---

6 Gardner expanded the scope of his research to include not only biology and psychology of humans, but also non-human animal studies and studies of exceptional learners, as he believed it would allow him to posit a theory that is as comprehensive as possible; “While the transfer from animal to human populations must be made cautiously, particularly in the intellectual realm, finding in these areas are far too suggestive to be ignored” (Gardner, 1983, p. 37).
depending on the cognitive task. For example, a mathematical reasoning task seems to utilize different neural paths than a spatial task of navigating a maze. This hypothesis is supported, Gardner argues, by physiological studies that show that when physiological damage occurs to certain parts of the brain or nervous system, some psychological capabilities may be left intact where others are disrupted. This suggests that brain functions are not ‘horizontal’ but are partitioned according to their task.

As I view the experience, both the findings from psychologists about the power of different symbol systems, and the findings from neuroscientists about the organization of the human nervous system, support the same picture of human mentation: a mind consists of a number of fairly specific and fairly independent computational mechanisms. (Gardner, 1983, p. 56, emphasis added)

Gardner argues that functional units in the nervous system suggest a biological basis for specialized intelligences, wherein different neural systems, located in different parts of the brain, perform different psychological functions (1983, p. 57). Thus, Gardner claims that intelligence is not horizontal, but rather modular.

It is claimed that, as a species, human beings have evolved over the millennia to carry out at least these seven forms of thinking. In a biological metaphor, these may be thought of as different mental ‘organs’ (Chomsky, 1980); in a computational metaphor, these may be construed as separate information-
processing devices (Fodor, 1983). Although all humans exhibit the range of intelligences, individuals differ—presumably for both hereditary and environmental reasons—in their current profile of intelligences. (Gardner & Hatch, 1989, p. 5)

Throughout his career, Gardner wavered on the exact number of modes of intelligence, but the number he usually settled on is either eight or nine. Although Gardner has made adjustments to the number of intelligences throughout his career, the exact number does not have as much bearing on our conversation as the fact that his theory calls for teachers to think of intelligence in terms of profiles rather than universal scores. As mentioned in the introduction, the current number adopted by the Ontario curriculum expectations is eight: verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical/rhythmic, interpersonal, intrapersonal, and naturalist (Ontario, 2013, p. 18). Each of these intelligences, he argues, resolves problems and difficulties specific and exclusive to that arena, and creates and finds problems as well (1983, p. 60-61). For example, one would use spatial and kinesthetic intelligence to untie a knot, but could also use these intelligences to create the problem of how to tie a knot in a way that looks pleasing, such as in a braid. Similarly, musical/rhythmic intelligence could be used to navigate how to dance with another person, but might also be used to raise questions about how one might dance to convey a new emotion.

Using biology to determine these intelligences’ origins, Gardner argued that the intelligences stem from a process called **canalization**. First postulated by the biologist C. C.

---

7 In 1995, Gardner stated he would add naturalistic intelligence to his list (1995a); in 1999, Gardner suggested he might also include existential intelligence. In 2016, he proposed a teaching or pedagogical intelligence may be considered, but did not formally add it to the roster.
H. Waddington, canalization typically refers to the genetic robustness of a species, but for Gardner’s purposes “refers to the tendency of any organic system (like the nervous system) to follow certain developmental paths rather than others” (Gardner, 1983, p. 37). A good metaphor for this is to consider the growth of a river; the more a body of water flows in a certain direction, the more likely it is to continue to flow in that direction because it digs a channel over time.

According to Gardner, canalization helps explain the regularity and predictability of development as well as the timing and sequencing of development. In a human embryo, for example, canalization orchestrates the migration of cells to regions where they will become different parts of the body, such as the brain and spinal cord.

Far from representing a random or accidental collection, the neural connections that are actually effective reflect the highest degree of biomechanical control. One beholds a stunning epigenetic sequence where each step in the process lays the groundwork for, and facilitates the unfolding of, the next. (Gardner, 1983, p. 37)

According to Gardner, once the process of development has begun, research shows that it is “surprisingly difficult” to divert its pattern from “prescribed developmental goals” (1983, p. 38), and this is credited to canalization. It is against this mechanized backdrop that Gardner begins to explain flexibility. To him, flexibility amounts to certain periods of neuronal development where a wide range of environments or damaging forces will still result in “proper effects” (1983, p. 38) or predetermined
results. For example, even in the face of hostile circumstances that might block one of the processes of development (such as an inhospitable environment, or a meddling researcher), the developing organism will likely find an alternative way to finish its work in becoming a functioning nervous system, or make a corrective adjustment later in its developmental course (1983, p. 38). More detail will be given on this process in upcoming sections, but for now it is sufficient to point out that Gardner grounds his discussion in biological determinism.

Through this process of canalization, wherein certain modes of thinking or problem-solving have become engrained through successive iterations, Gardner explains that there is consensus that the human brain evolved to have a number of special-purpose information-processing devices (1983, p. 55). These zones can be considered to be autonomous in two senses. First, they are not “yoked” to each other and operate according to their own principles; second, they can process information autonomously without guidance from any other module (1983, p. 55). He argues this is “heterochrony” at work, wherein different neural systems develop at different rates or ways, depending on their evolution and purpose (1983, p. 56).

Gardner thus emphasizes that through the work of canalization, the plan for intellectual growth is mostly in the genome (1983, p. 56-57). It is through this process of canalization of genomes that intelligences arose, and can be identified.

As for the issue of identity [of intelligence], evidence is accumulating that human beings are predisposed to carry out certain specific intellectual
operations whose nature can be inferred from careful observation and experiment. (Gardner, 1983, p. 33)

2.1.2. The role of culture

We have just seen how Gardner arrives at how a plurality of intelligences is likely to have originated through an extended study of the genome. However, Gardner also attributes some credit to external factors in the identification of intelligences, in addition to the internal factors already discussed. Gardner concludes that there is an external dominating factor in the identification of the intelligences: human culture. Culture, he argues, is what provides the “end states” for each intelligence (Gardner & Hatch, 1989, p. 6), as “it is the culture that defines the stages and fixes the limits of individual achievement” (Gardner, 1983, p. 27). The limits, or aims, of intellectual development lie in careers that can be attained in adulthood in any given society, matching each of the intelligences (i.e., poet, mathematician, athlete, etc.). Gardner argues that we can only understand intellectual tools insofar as they are utilized and recognized by the social environment; “Unless one lives in a culture where this domain is featured, one will make little or no progress in it” (1983, p. 26).

The incorporation of culture into his theory of intelligence is another way that Gardner was trying to distance himself from his intellectual forebears, as IQ testers and Piagetian theory do not view culture as playing much of a role in the development of intelligence; “the Piagetian individual advance[es] chiefly by himself along a path available to humans the world over” (Gardner, 1983, p. 27). Curiously, however, despite resisting Piaget for various reasons, he adopts a Piagetian principle that each intelligence
is developed in a series of stages, stating, “irrespective of domains, there should (in proper Piagetian fashion) be a stagelike sequence through which any individual should pass” (Gardner, 1983, p. 27). Gardner never explains why. He claims he agrees with Piaget that individuals differ in the speed with which they pass through these stages, but diverges in his belief that success in one domain does not mean success in another (1983, p. 27, 134). However, why he believes this to true is unclear and not justified. We might suppose that he assumes that since intelligences have “end states”, they must have “mid-states,” as well, corresponding with various states of canalization, but he does not specify this, so we cannot say for sure. However, we do know that Gardner believes he is presenting culture to be as important to a person’s development as biology: “One must conceive of the individual and his culture as embodying a certain stage sequence, with much of the information essential for development inhereing in the culture itself rather than simply inside the individuals’ skull” (1983, p. 27).

Yet there is reason to doubt this purported equality. Although Gardner argues that culture defines the intellectual ends of individual achievement, he also notes culture as a hindrance to researching intelligence. Gardner refers to culture as the “universal intrusion” (1983, p. 57) that makes his job as a neuropsychologist difficult because it can “‘mold’ or ‘exploit’ raw computational capacities” (1983, p. 29, emphasis my own) and make it difficult to examine underlying traits. This tension is evident in a passage where culture and intelligence are depicted as opposite sides of a research inquiry:

Culture makes it possible for us to examine the development and implementation of intellectual competences from a variety of perspectives:
the roles the society values; the pursuits in which individuals achieve
eversest; the specification of domains in which individual prodigiousness,
retardation, or learning disabilities may be found; and the kinds of transfer of
skills which we may expect in educational settings. (Gardner, 1983, p. 58)

Gardner paints a picture of intelligence research that is informed by a dualism of the
internal versus external, in which culture does much different work, and is of a different
element, than thinking. By this approach, the discrete, innate computational functions
defined as ‘the intelligences’ are paradoxically described as separate yet connected,
affected yet unaffected by the conditions of the individual’s existence. This leads Gardner
to have somewhat of a contradictory interest in the social environment. Culture is not to
be entirely disregarded because intellectual tools can only be understood insofar as they
are utilized and recognized by one’s social environment, but Gardner’s interest in it is
limited to the extent it aids us in ascertaining the “natural kinds” of symbol systems
(Gardner, 1983, p. 26).

2.2. The Growth of Intelligence

Gardner largely frames his discussion of the flexibility of intelligence as a tension
between canalization and plasticity. We have already discussed canalization as a
genetically engrained tendency to follow certain developmental paths. This is the
regularity he finds in neural development that represents to him that intellectual
connections are programmed (Gardner, 1983, p. 37). Flexibility, on the other hand, is
“the extent to which the intellectual potentials or capacities of an individual or a group
can be altered by various interventions” (Gardner, 1983, p. 31). The flexibility of intelligence is said to be important for educators to consider because the success of their own educational interventions relies on their knowledge of such: “Educational efforts must build upon a knowledge of these intellectual proclivities and their points of maximum flexibility and adaptability” (Gardner, 1983, p. 33).

2.2.1. Developmental flexibility

According to Gardner, most periods of developmental flexibility are found in the very early stages of development. For example, an experimenter can remove brain tissue from an embryo in early stages of development, and neighbouring cells will come to aid, either proliferating or devising an alternate route, so that development can proceed “normally” (Gardner, 1983, p. 40). There appear to be critical periods of development, however, as this same experiment, performed a little later on in development, will result in permanent damage (Gardner, 1983, p. 40).

The possibility for flexibility seems to be built into our biology in other ways, too. Our nervous system initially produces an excess of neuronal fibres and synapses that seem to aid in the malleability or modification of development. Gardner cites research that shows that after producing this excess of neuronal fibres, “a significant portion of the developmental process involves the pruning, or atrophying, of excessive connections which do not appear to be necessary” (1983, p. 43). This “selective cell death” may take anywhere from 15-85% of the initial population of brain neurons (1983, p. 44). Additionally, there is a spike in the generation of neural synapses that seem to coincide with periods of great flexibility or learning; for example, the density of synapses in
human beings “increases sharply during the first months of life, reaches a maximum at
the ages of one to two (roughly 50 percent above the adult mean density), declines
between the ages of two and sixteen, and then remains relatively constant until the age of
seventy-two” (1983, p. 44-45). The conclusion of this pruning constitutes “a functional
definition of maturity” (1983, p. 45). Gardner concludes, “Through survival of the fittest,
the number of neurons has now been adjusted to match the size of the field that they are
designed to innervate. … The critical period apparently ends when the process of synapse
elimination has progressed to the point where few, if any, synapses are still capable of
competitive interaction” (1983, p. 45).

Yet there is a limit to the role of genes in developmental flexibility, as certain
environmental factors seem necessary to moderate the success of development. Gardner
argues that it seems the systems that mediate development exhibit a “scheduled plan” that
“expects” certain sorts of input during these sensitive periods, and without these stimuli,
or with inappropriate stimuli, “the usual developmental goals will not be achieved, and
the animal will fail to function properly in its environment” (1983, p. 41). For example, a
cat’s vision system has been shown to require exposure to various stimuli for optimal
development. If a cat is only exposed to horizontal patterns, the cells that typically
process verticality will either atrophy or be taken over for another function. Or, if a cat is
only permitted to use one eye, its capability for binocular vision will degenerate. Thus,
the environment can be at the same time a catalyst and a foil for development. Although
Gardner admits of some environmental influence, he claims it is it is minimal once the
paths have been chosen (1983, p. 38).
To summarize, despite the role of the environment in shaping the developing organism, the blueprint for proper human function is seen as lying in the gene, as every aspect of development is seen as aiming toward a “normal” function that it plots. Canalization fosters normalcy, and flexibility ensures it.

Determination (or canalization) helps to ensure that most organisms will be able to carry out the functions of the species of the species in the normal way; flexibility (or plasticity) allows for adaptability to changing circumstances, including anomalous environments or early injuries. (1983, p. 42).

Thus a picture of human intelligence develops in which programming is the central component, orchestrating both the canalization and plasticity that come into play:

The plan for ultimate growth is certainly there in the genome; and, even given fairly wide latitude (or stressful circumstances), development is likely to proceed along well-canalized avenues. We could hardly have survived as a species for many thousands of years without a secure likelihood that we would all be able to speak, perceive, and remember many forms of information in relatively similar ways. To be sure, there is clear plasticity in the nervous system as well; and, especially during the early periods of growth, with its sprouting and pruning, there may well be tremendous resilience and adaptability in the system. These, too, aid survival. But that growth by alternative routes which plasticity permits is not always an
advantage. Newly contrived connections may well carry out certain processes adequately but prove inadequate for others or entail pernicious long-term effects. Programming, specificity, considerable early flexibility with some costs—such are the general principles of the nervous system that have emerged from our analysis. We can reasonably expect these same principles to apply when we consider how normal human beings come to negotiate various intellectual challenges and to advance in diverse symbolic domains. (Gardner, 1983, p. 56-57)

Flexibility and canalization also play crucial roles in Gardner’s concept of learning. Gardner uses the example of young birds to demonstrate these concepts in the acquisition of the skill of birdsong. Neurologically, the production of song stems from structures in the bird’s left hemisphere of the brain, and is mastered during the juvenile period of the bird’s life (1983, p. 45). Canalization and flexibility is present here just as it was discussed earlier in the possibility of alternative pathways to development—lesions in the left hemisphere of the brain will be more detrimental than lesions in the right hemisphere, yet the right hemisphere may be substituted in recovery of the left (1983, p. 46).

Just as in humans, canalization is responsible for mechanizing the functional acquisition of birdsong. However, malleability is present, too, as birds demonstrate an ‘excess’ of song that is eventually pared down (or canalized) to its cultural norm. Across species, in the first year of life, male birds produce a ‘subsong’ for a number of weeks that is equivalent to the babbling of babies. After this period, the bird then rehearses
longer intervals in a period known as ‘plastic song’. These bits are pieces of the song that the bird will later use in adult communication (1983, p. 45). How exactly the bird acquires these bits differs across species. During this time, “the bird emits during learning far more songs and song bits than it will vocalize during its adult prime” (1983, p. 46). In Gardner’s view, cultural destiny also factors in the acquisition of birdsong, as “birds are oriented to favor the songs from the environment which their species is destined to learn, and (relatively speaking) to ignore songs from other species or even other dialects of their own species” (1983, p. 46).

Thus, through the example of juvenile birds, Gardner concludes that learning occurs as an interplay between predisposition, environmental stimulation, and exploratory practice (1983, p. 46). Despite this claimed interrelation, however, by aligning this notion of learning with the expectations of a “scheduled plan” discussed earlier, there is an additional emphasis on the internal, supposedly innate offerings of the organism that are seen to lie dormant until the right conditions present themselves. Gardner cites the neuropsychiatrist Eric Kandel to explain how learning can be explained in terms of what happens at the cellular level,

Basic forms of learning, habituation, sensitization, and classical conditioning select among a large repertory of pre-existing connections and alter the strength of a subset of this repertory. … An implication of this view is that the potentialities for many behaviors of which an organism is capable are

---

8 Some birds, like the ringdove, can learn their song even in the absence of exposure to the correct model, whereas others (such as the canary) need feedback on their song but not exposure to the correct model (canary). Still others (like the chaffinch) need exposure to the correct model in order to learn their species’ song (Gardner, 1983, p. 46).
built into the basic scaffolding of the brain and are to that extent under
genetic and developmental control. … Environmental factors and learning
bring out these latent capabilities by altering the effectiveness of the pre-
existing pathways, thereby leading to the expression of new patterns of
behavior. (Kandel, unreferenced, in Gardner, 1983, p. 47, emphasis in
original)

However, this story of “potentialities” is underscored by a deterministic belief in what is
normal, or “scheduled,” development. Gardner thus paints a picture of environmental
factors drawing out latent capabilities in a manner similar to how he earlier described the
multiple intelligences as potentialities that exist dormant in an organism until the culture
draws it out according to its relevance.

2.2.2. Growth through social learning

Later in his career, Gardner attempted to extend his theory by aligning it with a
more interactive model of intelligence, distributed cognition. Distributed cognition is an
approach to the process of thinking that tries to move away from seeing thought as
something that only happens ‘in the head’ toward an approach that makes the social,
cultural, and technological tools people use when building their thinking a bigger part of
the story. “People appear to think in conjunction or partnership with others and with the
help of culturally provided tools and implements” (Salomon, 1993, p. xiii, emphasis in
original). In contrast with traditional, Cartesian pictures where intelligence is seen to
reside in the head, it appears, as Bateson remarked, that “memory is half in the head and
half in the world” (Bateson, 1972, in Pea, 1993, p. 47). Distributed cognition is thus an approach that considers that social, cultural, and technological supports things are “vehicles of thought” as much as the brain itself (Salomon, 1993, p. xv, emphasis in original). Gardner considers his work well-adapted to this approach, as he, too, has resisted a traditional approach to intelligence, and agrees culture is a crucial and necessary component to the growth of intelligence. His description of how his work aligns or supports distributed cognition affords us insight into how he believes this happens.

Earlier it was discussed that a person’s culture helps both to set the stage and direct the development of intelligences, on Gardner’s approach. He later extends this to explain that this occurs through the interaction of constraints and proclivities present in different elements of social life. Expanding on Bronfenbrenner’s (1979) ecological model of cognition, he visualizes cognition as occurring within and between three concentric circles of “cultural, local, and personal forces”, where all three work together to “shape the activity and skills of all people” (Hatch & Gardner, 1993, p. 166). In this way, they support, redirect, or discourage the development of individual intelligences. Cultural forces consist of the beliefs, institutions, and accepted practices in a society that provide the context and shape the exhibition of intelligences; “Cultural forces influence the kinds of skills people can exhibit, the way those skills are developed, and the purposes to which they are directed” (Hatch & Gardner, 1993, p. 167). Local forces are the “tools, people, and other resources” that help a person carry out their activities (Hatch & Gardner, 1993, p. 168). The innermost circle, personal forces, “represents the attributes and experiences that individual children bring with them” to the local settings (Hatch & Gardner, 1993, p.
attributes that include, among other things, their intelligences. In this more “situated” perspective to cognition, “intelligence cannot be separated from the particular conditions in which it is deployed” (Hatch & Gardner, 1993, p. 168). There is thus a level at which these conditions constrain intelligence, and Gardner articulates this relationship as one of environmental ‘affordance’: “If the materials, participants, and activities differ from one room or area to another, the affordances of each location and the ‘local effects’ may be different as well” (Hatch & Gardner, 1993, p. 169).

Affordances are “‘facts of the environment’ – functions that can be carried out given the properties of both the setting and the people (or animals) who occupy that setting” (Hatch & Gardner, 1993, p. 169). It is a concept Gardner borrows from cognitive psychologist J. J. Gibson (1977). They are any functional property that enables how a thing can be used. For example, in a classroom, an art area affords creative expression and exploration for a student, while the individual tools within that area, such as pencils and paintbrushes, afford the means for that creativity, such as drawing or painting, respectively. Notably, a pencil by itself does not afford drawing except within its larger cultural setting; in other words, a pencil may afford drawing in an art class, but would afford a different function in a math class.

Gardner presents affordances as interplaying between all three levels of the concentric circles; our cultural and local situations are said to afford us constraints every bit as much as our intelligence proclivities.

An individual’s intelligences, interests, and concerns are formed in interactions with peers, family members, and teachers, constrained by
available materials, and influenced by cultural values and expectations. The skills and interests a particular child brings into a setting may lead teachers or parents to rearrange the local setting and to provide different materials. Cultural values and expectations change over time with shifts in the interests and skills of individuals and alterations in the constitution of local settings. (Hatch & Gardner, 1993, p. 171)

Affordances are also said to influence the process of growth as we engage, learn, and are constrained by all three levels; “both cultural and local forces have a significant effect on the activities the children pursue, the skills they use, and the levels of performance they achieve” (Hatch & Gardner, 1993, p. 173). To demonstrate this, Gardner and his team of researchers observe a group of kindergarteners at play and assess the impact social interaction has on the development of their intelligences. They point out that a child with no natural proclivity in art (i.e. artistic intelligence), who draws little more than stick figures on his own, learns to draw more detailed pictures by asking his peers for tips on how to draw. This child, Gardner argues, is growing in his artistic intelligence when he “produces works with the help of his peers that are clearly more advanced than the drawings he completes on his own” (Hatch & Gardner, 1993, p. 181). Growth, Gardner argues, has occurred due to the interrelation of three distinct forces: the social setting of the kindergarten art table (cultural), in combination with the child’s natural proclivity to interpersonal skills (personal) affords the child the ability to use his peers as resources (local) in order to solicit advice and assistance to make his picture better (Hatch & Gardner, 1993, p. 181).
Distributed cognition is presented as a pluralistic approach to intelligence because “both endogenous factors such as genetic proclivities and exogenous factors such as personal experiences within a given culture influence the activities in which children choose to become involved and the abilities they subsequently develop” (Hatch & Gardner, 1993, p. 169). Gardner believes his pluralistic approach to intelligence is well-adapted to distributed cognition because his theory of multiple intelligences, too, looks to extra-cranial elements, such as culture, to explain the process of thinking.

Gardner deliberately spans both endogenous and exogenous forces by suggesting that there is no pure “aptitude” that can be assessed apart from a person’s experience in particular domains such as language, music, and mathematics. … We disagree with the traditional view, which places abilities in the head and stipulates that certain skills and performances necessarily follow from these abilities; yet we recognize that individuals have the potential to use certain skills or intelligences or to achieve certain levels of performance… (Hatch & Gardner, 1993, p. 170)

While this view of cognition and intelligence suggests that personal forces are attributes that individuals carry with them from one setting to another, these forces are not independent properties located inside a person’s head – they are not properties of the mind “solo”. For one thing, the personal forces themselves are always already a reflection of the cultural and local forces in the settings where individuals have spent their time. … In addition, the effects
of these personal forces on behavior and development are always contingent on the cultural and local forces in particular situations. (Hatch & Gardner, 1993, p. 184)

This additional insight, Gardner argues, provides educators a renewed benefit in their approach to students, both in drawing “wider conclusions about how they learn and the conditions in which they might learn most effectively” (Hatch & Gardner, 1993, p. 185) and how “parents and educators can develop programs and strategies that are responsive to the changing needs of individual children as well as to the changing circumstances in our societies” (Hatch & Gardner, 1993, p. 186).

2.3. Framework Limitations

It should be noted that despite the widespread adoption of Gardner’s framework in the North American education system, reception of his work among follow psychologists has not been so enthusiastic; MI theory has not gained widespread acceptance in the research community (Edmunds & Edmunds, 2010, p. 190). One issue is the problematic structure of his intelligence theory, which is theoretically based rather than data-driven, and has not stood up to subsequent testing:

Gardner’s original conceptualizations of the system decried, and even denied, any amount of coalescence between these eight separate structures, but several researchers have demonstrated statistical connections between several of them. In fact, in the more than 25 years since Gardner’s theory was
proposed, there has been no verification of the separateness of the structures, leaving the differences between the structures viewed as semantic at best.

(Edmunds & Edmunds, 2010, p. 188-189)

Further, some researchers feel it is problematic that MI theory is not linked or supported by any other research from the past 100 years (Edmunds & Edmunds, 2010, p. 189).

One teacher education handbook in educational psychology suggests that despite its shortcomings, MI theory persists because it does have practical educational uses – we know that students think and learn differently, and it makes sense that instruction should be carefully planned to avoid predominantly focusing on one form of reading and writing.

In the final analysis, if MI theory causes teachers to teach differently so as to accommodate students who learn and process information differently, then educational practice is much better off for it. However, having said that, there is currently little empirical support for the value-added effectiveness of MI theory when it is adopted on a school-wide basis. Like many other concepts in educational psychology, teachers need to completely understand MI theory, then judiciously select and apply the aspects of it that may enhance their students’ learning. (Edmunds & Edmunds, 2010, p. 190)

These popular debates of his work are important to consider, but do not as yet address concerns relevant to this particular discussion, which is how learning and student differences are conceived under this approach, and what the consequences are of
approaching issues of diversity under this approach. Thus, in what follows, I will raise two challenges focused on this problem, as well as consider their consequences for MI theory as an account of diversity.

2.3.1. *The conflicting role of culture*

It appears Gardner has made a case that intelligence is constituted by ‘forces’ both internal and external to the learner. Internally, the biological and psychological makeup of a person configure half the thresholds of a learner’s potential; externally, a person’s culture configures the other half by setting the ends of development and constituting the affordances available to the learner. Whereas Gardner presents these as equal parts in the process of minding, the bigger picture is not so balanced. Despite his later claims that cognition is distributed, it must be remembered that this is predicated by Gardner’s initial finding that although our understanding of intelligence is constituted by two dominating factors, the biological and the cultural, it is the biological side that constitutes the “natural kinds” and the cultural side, although assisting in illuminating intelligence, that serves to obfuscate it (Gardner, 1983, p. 26). Thus, although the process of minding contains multiple forces of nature, some (the internal) appear to be presented as more integral than others.

By positing mental entities as separate or extractable from culture, Gardner is promoting a view of mind that is both essentialist and nativist. I borrow my definition of essentialism from Oyama (2000), who describes it as

42
an assumption that human beings have an underlying universal nature that is more fundamental than any variations that may exist among us, and that is in some sense always present—perhaps as a “propensity”—even when it is not actually discernible. (p. 131)

This matches Gardner’s description of intelligences well: Our several computational modes, as part of our underlying universal nature, are more fundamental than the variations we may perceive, and these intelligences are always present, even if one’s culture doesn’t foster them to any distinctive extent. This account is also nativist in that these traits are presented as innate or inborn qualities, selected after eras of evolution. Gardner’s account fits both these features because, although the expression of these intelligences may look different from culture to culture, the underlying causes are said to be the same. Not having distinguished itself from MI in this respect, in the student-centred approach of DI, too, diversity of intelligence is presented as exhibiting one or some of eight fundamental kinds. This suggests one assumption that underlies Ontario’s use of individualized instruction, and thus their account of learning diversity—that mental entities are a fixed set of traits which are believed to be possessed and function similarly regardless of geography and time.

The interpretation of nativism is supported by the way Gardner tried to incorporate evolution. When Gardner talks about people or agents as responding to their local and cultural environments, and intelligences developing as a result of these interactions, he is describing intellectual adaptations as products of evolution. Thinking of our multiple intelligences as crafted from millennia of adaptation provides a historical
account of thinking, which appears to provide some robustness to his model. But there is a conceptual catch to this story—“So long as we persist in thinking of evolution as adaptation, we are trapped into an insistence on the autonomous existence of environments independent of living creatures” (Lewontin, 2001, p. 63 in Walsh, 2014, p. 217). In other words, by positing the various modes of intelligences as responses to environmental demands, Gardner is committed to an ‘inside/outside’ approach to intelligence in which the features of human intellect are reactions to problems (of communication, space, quantity, or otherwise) that have been proposed by the local and cultural setting.

However, some researchers in evolutionary disciplines have taken Gibson (whom Gardner cited in his approach) to mean the opposite of what Gardner intended, which raises difficulties with his picture. The ‘inside/outside’ picture Gardner paints clashes with a more dynamic approach to affordances in a sphere of biology known as evolutionary developmental biology, or evo-devo (Lewontin, 1991, 2001; Walsh, 2012, 2014). Evo-devo suggests that evolution and development affect one another, rather than evolutionary processes having one-way effects on development (such as genetic determinism). In other words, developmental contingencies constrain evolutionary possibilities, just as evolutionary possibilities constrain developmental sequences.

Gardner’s emphasis on the gene driving intelligence is typical of the traditional 20th century gene-centric interpretation of evolution. In this reading, a developmental system, such as that of a biological organism, is typically construed as one of “tightly predictable self-regulation” (Oyama, 2001, p. 185). The ‘reliability’ of development is seen as an inheritance and the ‘environment’ is thus seen as a standard background in no
need of explanation in itself (Oyama et al., 2001, p. 1). However, gene-centric interpretations of development have been derided as “modern preformationism,”—in which an organism’s form is as good as “preformed,” based on the information in its genes (Oyama et al., 2001, p. 4). Researchers, like Oyama, take issue with the primacy given to the gene-environment grouping within the story of evolution and even the gene-environment dichotomy itself.

The standard neo-Darwinist view is that genes are the only thing we inherit, however, Jablonka and Lamb (2005) argue there is a range of resources that are passed on, such as environmental, behavioural, and language inheritance systems. A rabbit, for example, may teach its young a preference for eating juniper berries; or, an organism may develop a new preference that may then be passed on, such as the species of bird that learned to open milk bottles to feast on the cream (Jablonka & Lamb, 2005). “There are multiple inheritance systems, with several modes of transmission for each system, that have different properties and that interact with each other” (Jablonka, 2001, p. 100). The replicator-centred, gene-derived view of heredity is not only limited and misleading, it is argued, but is not even specified in Darwin’s original selection theory (Jablonka, 2001, p. 99). Thus, the emphasized dichotomy between genes and environments is argued to be only one possible grouping among many possible alternatives, because there are different ways of transmitting forms and characteristic behaviour to offspring besides passing on genes. Although the gene-environment grouping may be helpful for some purposes, it is less so for others (Oyama et al., 2001, p. 2).

By this account, “the life cycle of an organism is developmentally constructed, not programmed or preformed. It comes into being through interaction between the
organism and its surroundings as well as interactions within the organism” (Oyama, 2001, p. 4). This leads to a conception of evolution as a process of construction rather than prefiguration (Oyama et al., 2001, p. 6). This more transactional account, where organisms are actively involved with, rather than passively carried by, the processes of development and evolution, sets the groundwork for the field of study known as evo-devo. Here, organisms are able to “[change] which elements of the external environment are part of the developmental system and thus able to influence the evolutionary process in that lineage” (Oyama et al., 2001, p. 6).

If systems are as interrelated as this research suggests, framing evolution in terms of organism/environment dichotomies appears to be misleading. Developmental systems theory, an example of a field of study connected to evo-devo, specifically presents itself as an approach to biology without the use of dichotomies (Oyama et al., 2001, p. 1). Here, the internal/external relationships so central to a gene-centric view of evolution are seen as playing only a small role in the larger story of evolution (Oyama, 2001, p. 182). In the place of dichotomies is a view of “both development and evolution as processes of construction and reconstruction in which heterogeneous resources are contingently but more or less reliably reassembled for each life cycle” (Oyama et al., 2001, p. 1, emphasis in original). Gardner’s view of affordances, it will be shown, clashes with this model, and promotes a more limited view of evolution.

Thus far, Gardner has spoken in great detail about what the local and cultural environments afford thinking agents such as kindergarteners. In this interpretation, the children are passive agents, merely responding to the resources of their environments. But something that is highlighted in philosopher of biology Denis Walsh’s reading of
Gibson’s account of affordances that is not as clear in Gardner’s interpretation is that affordance goes both ways:

The affordances of the environment are what it offers the animal, what it *provides or furnishes*, for good or ill… I mean by it something that refers to both the environment and the animal… It implies the complementarity of the animal and the environment (Gibson, 1979, p. 127 in Walsh, 2012, p. 97, emphasis in original)

Gardner has overlooked that what the environment affords is only discernable insofar as what the child brings to the table, so the child plays a significant role in the constitution of her environment. As Walsh explains, “What the agent can do depends upon what the environment affords. But, conversely, what the environment affords depends very largely on what the thinking agent can do” (Walsh, 2012, p. 98). What the environment *is* depends in great part upon how it is being perceived: “A brick wall affords very different possibilities to me and a gecko. To me it is a barrier; to a gecko it is a right of way” (Walsh, 2012, p. 98).

This suggests that culture has a deeper ontological connection with intelligence than Gardner indicates; by constituting, as well as shaping, the thinking agent, it is logically unsound to consider culture a “universal intrusion” as Gardner suggests (1983, p. 57). What is perceived as an affordance is inextricable from the agent itself, because as agents we are imbued with certain “thresholds” of meaning-making and physical adaptability (Bateson, 1979). In this sense, environments are “organism-indexed faces of
the world” (Sanders, 1993, p. 290, in Walsh, 2012, p. 98). We are not merely responding to the environment, but what we perceive of the environment is always already filtered through our habits of meaning and access⁹. This more nuanced approach to the affordances of environmental resources gives reason to question Gardner’s theory of intelligences as innate computational systems. After all, Gibson himself may have understood this, according to Walsh’s interpretation:

For Gibson…perception is not computation. It is not an inner process decoupled from the environment. Perception can only be understood from the perspective of an agent actively engaged and embedded in its environment. The agent isn’t merely an intermediary between the external environment and the internal processing of perceptual inputs. It is the source of perception. The locus of perception is not some inner mental realm. Perception is spread throughout the entire organism-environment system. (Walsh, 2012, p. 98)

The difference between interpretations may center on the question of what it means for an organism to engage with its environment. Walsh describes the environment as “the physical world as engaged in by the organism or agent” (2012, p. 99). The difference between a computational theory of engagement and an actively embedded approach is that, under the latter, “an affordance landscape is a dynamic system; as either of its components change, so does the whole system” (Walsh, 2012, p. 99). Saying the whole system changes suggests that the ‘solutions’ we develop (such as the various

⁹ In discussing the environment in this way, I am temporarily utilizing a dualistic form of description—as though “the environment” were there to be perceived prior to the process that makes it an environment.
intelligences) for the ‘problems’ the environment sets out for us (spatial, numerical, interpersonal, etc.) reflect each other in a manner in which neither side is the default. For example, consider how evolution has helped solve the ‘problem’ of how to move through water. Walsh (2012) points out that there isn’t a unique solution, that the solution depends very much on who is doing the solving:

For example a harbour porpoise (*Phocoena phocoena*), at a length of 1.5 to 2.0 m long and a mass of 65 kg, experiences the viscosity of water much as we do. The porpoise’s ‘solution’ to the problem of locomotion is to move through it by establishing smooth laminar [streamlined] flow along its body length. The laminar flow, and the consequent propulsion of the body, is set up by the undulations of a powerful fluke, the propulsive power of which is accentuated by the presence of a narrow caudal peduncle. The solid, narrow, peduncle ensures the smooth flow of water past the caudal fin. Things are very different for a paramecium. A paramecium lives in an environment of very low Reynolds’ numbers. At a length of 200 µm, it finds water extremely hard to shift. A paramecium experiences the viscosity of the water much as we would experience being immersed in tar. Their ‘solution’ to the ‘problem’ of locomotion in water is a helical band of cilia. The cilia beat in propulsive waves and in doing so ‘screw’ the paramecium through its extremely thick medium. (p. 100).
These two widely different responses to the same problem demonstrate how important it is to consider the characteristics the agent brings to solving those problems. Context not only matters, it constitutes the problem. As a result, problems cannot be seen as centrally occurring in the environment, but relying on an acting agent to frame them, as they are “as much the consequence of the way the organism lives as it is the extra-organismal setting in which it lives” (Walsh, 2012, p. 100). Similarly, “what counts as a solution is determined as much by the nature of the organism as by the extra-organismal setting” (Walsh, 2012, p. 100). This example suggests that whatever the adaptive solution is, be it a fin or a mode of intelligence, we must understand it as a response to an affordance—an affordance the agent constituted.

A reader sympathetic with Gardner may perhaps object that he has already accounted for this, as Gardner states, “the personal forces themselves are always already a reflection of the cultural and local forces in the settings where individuals have spent their time” (Hatch & Gardner, 1993, p. 184). Is it not possible that he has already considered the interrelation between ‘inner’ and ‘outer’ components?

I am not convinced that he has. Prior to observing his kindergarteners at play, Gardner sets the stage by first identifying their “natural proclivities” according to how they align with his multiple intelligences scale, so as to be able to demonstrate the impact local and cultural forces have on mental phenomena. In the example discussed, the child showed existing interest and capability in the visual arts. (This is identical to how he encourages teachers to use his framework—by assessing students according to a profile before setting out their learning material.) In this regard, he is pointing to the child’s intelligence profile as a fixed element of observation, and has removed this element of
the interaction from any meaningful influence of development. Certainly he claims the child’s artistic intelligence “grows” when the child increases his ability to draw by watching others, but this is a very limited form of growth, occurring only on a scale with fixed and determinate ends. The evokes a passage on growth by Dewey, who says,

Progress is sometimes thought of as consisting in getting nearer to ends already sought. But this is a minor form of progress, for it requires only improvement of the means of action or technical advance. More important modes of progress consist in enriching prior purposes and in forming new ones. Desires are not a fixed quantity, nor does progress mean only an increased amount of satisfaction. With increased culture and new mastery of nature, new desires, demands for new qualities of satisfaction, show themselves, for intelligence perceives new possibilities for action. This projection of new possibilities leads to search for new means of execution, and progress takes place; while the discovery of objects not already used leads to suggestions of new ends. (Dewey, 1916, p. 224)

Progressing from a stick figure to a more detailed figure is a limited form of progress because we already know what the end product should be—improvement of an artistic intelligence that we were already looking for in the first place. It does not account for more thoroughgoing adaptability that other evolutionary thinkers have pointed to where the intelligences themselves would be seen as subject to change along with the affordances of the surrounding environment.
The difference seems similar to what Walsh describes as the difference between ‘reciprocal causation’ and ‘reciprocal constitution’ (2012, p. 103). Reciprocal causation appears consistent with what Gardner is defending: his account emphasizes how agents “effect some tangible alteration to the physically specifiable conditions of their environment” and how “these modified physical conditions, in turn, redound upon the organisms” (Walsh, 2012, p. 101). Or in other words, our natural proclivities in ‘artistic intelligence’ causes us to create art spaces in classrooms and avenues toward artistic careers, and those career and classroom possibilities, in turn, help us to grow in our artistic intelligence.

Reciprocal constitution, however, is when “in the commingling with their environments, these organisms both exploit and create their conditions of existence” (Walsh, 2012, p. 104). In this reading, the organism or agent is more than a go-between among internal traits and external conditions, as the agent has power to both effect change to its environment by altering its contingencies and effect change in itself by changing location or even its own form (such as its structured sensitivities) (Walsh, 2012, p. 103). This reading thus suggests that any ‘intelligence’ features Gardner perceives likely came about due to an “environmentally-induced change of form” which in turn issued a new set of affordances to those intelligence features. In this sense, agents have both created and changed their affordance landscapes. Importantly, these resources “are supplied not from within the genomes of these new forms, but from their active engagement with their newly altered affordance landscape” (Walsh, 2012, p. 104).

Two consequences follow. First, the simple computational representation of intelligence that Gardner prefers is undercut because the adaptability of the agent “makes
it inconceivable that the complex genetic circuitry observed, and perturbed, in the
developmental studies of modern organisms can constitute functional machinery for the
production of organismal forms in the same sense that CPUs and RAM chips are
105). In other words, living beings respond to changes in ways that computers can’t. The
computational metaphor depicts an image of mind where its framework is given, fixed,
and unadaptive. Second, as a result of this ‘commingling’, it becomes “difficult, and
often pointless, to differentiate the contribution of sub-organismal processes from those
of the extra-organismal environment” (Walsh, 2012, p. 105). The reason is that the
contributions of the living being and environment are “indistinguishable in kind” because
they are incorporated equally and simultaneously (Walsh, 2012, p. 105). It is, as Bateson
(1979) said, that “evolution must always, Janus-like, face in two directions: inward
towards the developmental regularities and physiology of the living creature and outward
toward the vagaries and demands of the environment” (p. 220), while recognizing that
each defines the other. The upshot is that change and inheritance are not processes that
occur to an insulated, internal domain like the distinct intelligences Gardner posits,
regardless of how interrelated they are with each other and their local and cultural
environments; “they take place in an affordance landscape constituted by the organism’s
capacity to exploit, and adapt to, the resources available to it, both ‘inner’ and ‘outer’”
(Walsh, 2012, p. 105, emphasis added).

The key to this engagement is plasticity, which is of a different kind than Gardner
outlined. In Gardner’s account, the plasticity of our intelligences consists of alternative
available genetic pathways to allow the same cognitive structures to develop. But
plasticity in Walsh’s more ‘transactional’ account means to maintain viability in response to both inner and outer perturbations (Walsh, 2012, p. 106). To paraphrase, we are not robust because we are built to not buckle under stress; we are robust because our physiology is flexible or adaptive (Walsh, 2012, p. 106). This suggests that the form intelligence takes is not integral to human development, nor is it a ‘natural’ kind. Rather, its present form is but one of a vast number of potential forms, dependent on a host of contingent factors; “The phenotypic repertoire of organisms masks an enormous amount of latent developmental variation within a population. Changes in the affordance landscape expose this variation” (Walsh, 2012, p. 107). Intelligence is not a leader in our adaptive evolution; it is a follower, resolving the problems the thinking agent affords. In other words, “plasticity consists in the fact that organisms are goal-directed systems, adaptively engaged in their environments” (Walsh, 2012, p. 107), not in the fact that we contain innate structures that are striving to be expressed. Under this reading, our latent variation is exposed by engagement with the environment according to our goals in engaging it, not innate intelligences. To connect this concept to a more directly educational example, we might consider how this shapes the language we use to discuss a student’s capacity to think. A student’s ‘intelligence,’ or ability to function and solve problems with foresight, depends on the issues or difficulties with which life has presented her in helping her frame the problem, as well as the available tools she has or recognizes for dealing with them. In this view, every child has a unique family of abilities, rather than a common underlying form (or forms) of intelligence.

Gardner’s notion of intelligences growing to a culturally appropriate state of completion only makes sense when the concept of intelligence has been decoupled from
the environment. But in a more embedded or situated approach, ‘internal’ and ‘external’
evolve in tandem, even if it may appear that only one side is obviously changing.

Organisms build and alter their affordance landscapes by making adaptive
changes to their own form. Some of these changes are intergenerationally
stable. Over time, organisms and their affordance landscapes evolve
conjointly. If adaptive evolution occurs in this way, then one cannot
differentiate the causal contribution of the extra-organismal environment to
form from those of the organism. (Walsh, 2012, p. 109, emphasis added)

This doesn’t mean that we can’t study intelligence, and it likewise doesn’t mean
there aren’t some uses to viewing the intelligences Gardner has identified as adaptive
forms. By discussing the modular forms of thinking that Gardner believes he has
identified, for example, we can think about the challenges students are likely to face in
educational environments, as presently organized, and consider how to address those
challenges. But it doesn’t mean that we can discuss environmental influences as evolving
wholly separate from the agents that engage them.

This more transactional approach conflicts with the view of intelligences that
Gardner identified as being dependent upon yet extractable from culture. By attempting
to align his work with distributed cognition, this aspect is especially conspicuous. It
seems that Gardner has simply deposited his previous conclusions onto a discussion of
dynamicism, rather than allowing an inquiry about dynamicism to amend his results. This
challenge seems supported by the editor’s introduction to Gardner’s work, which is
described as a “less radical” conception of the dynamicism of distributed cognition, where “‘solo’ and distributed cognitions are still distinguished from each other and are taken to be an interdependent dynamic interaction” (Salomon, 1993, xvi). The result of this identified tension is that one has reason to question whether the traits Gardner perceives in his research subjects are as autonomous as he suggests.

2.3.2. The epistemological and teleological limits of science

Gardner acknowledges a limitation of inquiry is its inability to proceed completely by induction (1983, p. 59). For this reason he says that despite his attempt at as building as comprehensive an account as possible, he cannot claim to have objectively true answers. However, he appears to think he has sidestepped this issue as much as possible, as his work is open to revision:

We confront here a question not of the certainty of knowledge but, rather, of how knowledge is attained at all. It is necessary to advance a hypothesis, or a theory, and then to test it. Only as the theory’s strengths—and limitations—become known will the plausibility of the original postulation become evident. Nor does science ever yield a completely correct and final answer. There is progress and regress, fit and lack of fit, but never the discovery of the Rosetta stone, the single key to a set of interlocking issues. (1983, p. 59)

Despite these limitations, which prevent him from objectively saying he has attained a “master list” of intelligences (1983, p. 60), Gardner suggests scientific inquiry, like his
own, is still useful because it can help with reviewing and organizing emerging evidence, and assist in constructing a “better classification” of intelligence than we had before (1983, p. 60). But this is where his tentativeness ends. For the duration of his work, Gardner presents his roster of intelligences with such definiteness as to make us forget the inductive nature of science. He even concludes he has obtained what he believes to be a “reasonably complete gamut” of intelligences (1983, p. 62). As such, any tension he raises about the tentativeness of science is brushed aside as MI theory is presented as a comprehensive account—after having just acknowledged the impossibility of providing such an account.

…it seems within our grasp to come up with a list of intellectual strengths that will prove useful for a wide range of researchers and practitioners and will enable them (and us) to communicate more effectively about this curiously seductive entity called the intellect. In other words, the synthesis that we seek can never be all things for all people, but it holds promise of providing some things for many interested parties. (Gardner, 1983, p. 60, emphasis in original)

There is a kind of double-speak present, where it is openly admitted that science cannot provide us objectively true answers yet also held that a list of intellectual strengths be “within our grasp”. The cognitive dissonance is not explained. Gardner’s humble promise that his results cannot be “all things for all people, but…some things for many people” is unclear and misleading until it is explicated what exactly that thing could be. By all
accounts, Gardner believes his approach has enough objective truth value that it can and should determine educational strategies for learning, as he concludes that the link he has established between behaviour and biology is promising enough that we should believe we can apply the principles to institutions of learning (1983, p. 48). Schools, as we have already seen, have responded eagerly, promising that with proper alignment of suitable environmental affordances for each students’ individual strengths, learning will occur; “Being aware of all eight forms of intelligence enables teachers to plan activities that build on the strengths of each student and that help students to develop their intelligences in areas that are not naturally strong” (Ontario, 2006a, p. 22). It is thus evident that our education system has promoted Multiple Intelligence theory as though that “reasonably complete” list of intelligences was, in fact, within our grasp. Thus, one hidden assumption we find supporting DI and student-centred instruction more generally is that the study of mental entities can and does result in an approach that presupposes its comprehensive explication.

One of the most profound effects of differentiation on education has been to reveal limitations to one-size-fits-all lesson planning, suggesting, instead, different lessons or experiences for different pupils (Subban, 2006). However, despite its appeal, it may not be immediately apparent that this approach is not as open to variety as it seems. Despite having purportedly been developed to account for evolutionary variation in learners (Gardner, 1983; Egan, 2003), Gardner’s research overlooks a key element of our biological and cultural ‘heritage’ that has only been hinted at thus far—that is, our ongoing diversification. As we reciprocally constitute the phenomena in our physical and cultural environments, we are engaged in several simultaneous layers of variation: for
example, the adaptability that we exhibit as we purposively strive to reach our goals (Walsh, 2015) and the forces of evolutionary change—that is, change through chance variation and natural selection (Darwin, 1859). These forms of variation are not unrelated; both point to the existence of innumerable latent possibilities that require preferential selection for growth. Commonly, research that tries to investigate mental entities from an evolutionary perspective, including MI, chooses to describe intelligence as a component that has already been naturally selected (that is to say, Gardner’s mental entity of kinesthetic intelligence, for example, has been selected for some adaptive benefit). But this raises questions about what the ongoing evolution of mind means for scientific behavioural models that attempt to encapsulate adaptation. This raises a significant challenge to the purported aims (and, consequently, the success) of the MI model. Other, more generally evolutionary models suggest that we continue to change beyond the traits Gardner observed; this further suggests that the typological way of thinking promoted by Gardner cannot admit important individual differences or uniquenesses not already coded in his scheme10.

As a component of development, evolution is often thought of as little more than the random variation that makes an organism better or worse adapted for survival, where the contingencies it faces are given. However, researchers in various fields conclude that evolution is not merely a passive glitch in our otherwise steady trajectory of development, but is a propelling feature of our growth (both biological and cultural) that has significant consequences for ontology and epistemology (Bateson, 1979; Prigogine & Stengers, 1984; Oyama, 2000; Lewontin, 2001). Evolutionary change is more than an

---

10 To provide another educational example, even fields of study typically considered ‘unified’ can be seen to be subject to this same kind of growth. The field of mathematics, for example, itself changes as a result of individuals with new kinds of talents or abilities not fully accounted for in previous mathematics.
occasional blip on a screen; it is a common occurrence that not only complicates
seemingly orderly development but *individualizes* its trajectory. Thus, individuals, taken
as a whole, are unique and non-repeatable, to an extent that questions whether any fixed
scheme (such as Gardner’s) can possibly encode all possible traits or characteristic ways
of behaving.

This challenge to essentialist ideas about natural kinds raises a question about the
appropriate teleological underpinnings of science. According to Walsh, “teleology is a
mode of explanation in which the existence or nature of an object or event is accounted
for by citing the purpose it subserves.” (Walsh, 2015, p. 186). When, as Gardner
suggests, a phenotypic novelty, such as a mode of intelligence, is evolved to fit a cultural
solution, that solution is presented as the purpose it subserves. But we can take this
another step further: when *research* is presented as seeking out or confirming a final
cause, the acquisition of finality is presented as the purpose *it* subserves. Hints of this
interpretation have already been shown to be evident in Gardner’s position, in his
promise of a “complete gamut” (Gardner, 1983, p. 62) and is further evidenced by his
own definition of his quest:

> Taken together, these sets of questions add up to a search for general
> principles that govern the nature and the development of human intellectual
> capacities, and that determine how these are organized, tapped, and
> transformed over a lifetime. (Gardner, 1983, p. 32)
Some psychologists have recognized elements of this limitation in their own field. Cronbach (1957; 1975) raises a critique of educational research that psychologists’ desire for objective answers do not align with the changing nature of the world; “We tend to speak of a scientific conclusion as if it were eternal, but in every field empirical relations change” (Cronbach, 1975, p. 122). To Cronbach, the basis of this error lies in the standard approach to psychological testing; for the sake of generalizability and repeatability of results, researchers view at least one of the variables in a testing situation as the centre of focus. (Earlier, we saw this was Gardner’s case when he held the artistic mode of intelligence as a stable entity in his observation of kindergarteners.) The expectation is that with precise enough research, a rule may be developed that can accurately predict the state of this variable in the future:

The forecast of Y from A, B, and C will be valid enough, if conditions D, E, F, etc., are held constant in establishing and in applying the law. It will be actuarially valid, valid on the average, if it was established in a representative sample from a universe of situations, as long as the universe remains constant. (Cronbach, 1975, p. 125, emphasis added)

However, Cronbach points out that a limitation of this type of research is that it overlooks the effects of interaction of these variables. He argues that a more comprehensive approach to psychology would consider the effects of interaction, seeing as the cases in which there is little interaction are only special cases of this larger model. Further, the interaction effects are themselves also changing (or the interactions have interactions). In
a world in which even the most general relationships are changing, the predictive power of universalistic research is limited as a result, as “an actuarial table describing human affairs changes from science into history before it can be set into type” (Cronbach, 1975, p. 123). Hence, he argued, a limitation of any controlled, scientific investigation is that it offers a mere snapshot of a process that is dynamic and evolving.

The aim of social and behavioral science, since Comte, has been to establish lawful relations comparable to those of the traditional natural sciences. … We need to reflect on what it means to establish empirical generalizations in a world in which most effects are interactive. (Cronbach, 1975, p. 121)

This isn’t to say, he continues, that humankind’s actions are unlawful, but rather that “we cannot store up generalizations and constructs for ultimate assembly into a network” (Cronbach, 1975, p. 123). Thus, research is not capable of the kinds of predictions that a positivist theory would present. Predictions are, at best, provisional. This may call for a change to the purported aims and goals of such research.

Too narrow an identification with science, however, has fixed our eyes upon an inappropriate goal. The goal of our work, I have argued here, is not to amass generalizations atop which a theoretical tower can someday be erected…[but] to gain insight into contemporary relationships, and to realign the culture’s view of man with present realities. (Cronbach, 1975, p. 126)
Cronbach argues that predictions are still useful even if they cannot be applied with law-like surety. Behavioral research can still make contributions in the form of describing social phenomena, providing us new concepts with which we can more intelligently approach our environments (Cronbach, 1975, p. 126). However, behavioral and educational science can aspire to no more than this provisional application; “though our sketch of man may become more elaborate, it will remain a sketch” (Cronbach, 1975, p. 126). The confusion of supposing our theories can capture all there is has been summarized as the difference between the map and the territory, or, as Bateson (1979) put it, drawing from Korzybski, “the name is not the thing named” (p. 190). Otherwise, we risk enframing ourselves in a way that is not open to individual uniqueness and evolution in thought and otherwise.

2.4. Discussion Directions

The above discussion served to suggest it is a plausible hypothesis that beings constitute their environments as much as being constituted by them. I have also attempted to demonstrate that this is a contrary position to that of Gardner, who prefers to view development as a series of forces in play. According to a more generally evolutionary account, Gardner’s interpretation of the process of development, being a story of the impact of personal, local, and cultural forces, is problematic because it necessitates a conflict between ‘inner’ and ‘outer’ sets of influences, when there is evidence that both can be shown to shape and even constitute each other. A possible alternative to considering development as a ‘positive’ or aggressive struggle between competing forces is a ‘negative’ model wherein adaptations occur through chance variation and natural
selection, a process of biased elimination. This posited interpretation of ‘elimination’ differs from what Gardner pointed to in his account of plasticity and flexibility. To Gardner, these processes of eliminating excess potentialities served to ensure the production of ‘normal’ development that results in natural, underlying kinds. This alternative position seeks to acknowledge and utilize a framework in which ongoing adaptation is possible at all levels, as organism and environment constitute and change each other. By allowing for adjustments via a process of mutual constitution, this approach allows an explanation of mental and environmental phenomena in a manner that views neither as occurring by default. This perspective is supported by biologists who work in the evolutionary developmental (evo-devo) approach, suggesting that there are other drivers of evolution besides genetic determinism that must also be woven into evolutionary explanations (Laland, 2014). A recent response to work in evo-devo, considered in relation to psychological systems specifically, is found in the developmental systems approach (Oyama, 2000; see also Gottlieb, 2000). In this approach, “forms and functions do not arise from the simple reading of a genetic blueprint, but emerge via the bidirectional transaction between all levels of biological and experiential factors, from the genetic through the cultural” (Bjorklund & Bering, 2002, p. 351).

Despite there being numerous proponents of a bidirectional, transactive understanding of evolution of both body and mind, very little has been written that connects this approach to education. Those who have attempted to connect the developmental systems approach to education (Bjorklund & Bering, 2002) suggest its

---

11 This position is sometimes described as the interaction between phylogeny and ontogeny, or of individuals and populations.
only upshot is to prescribe educative practices that stay within the developing mind’s 
natural confines, a recommendation noticeably similar to Gardner’s: “We only wish to 
suggest that nature has created a developmental range within which these early learning 
experiences should proceed logically, and by artificially accelerating some forms of 
learning, parents and educators might, through tinkering with complicated developmental 
systems, unknowingly put their children at a later disadvantage” (Bjorklund & Bering, 
2002, p. 367). However, I am not satisfied that a normative approach to educational 
practices is the best that an extended understanding of evolution can give us. Bjorklund 
and Bering’s recommendation still seems to posit a fixed set of pathways for education 
while there may (again) be possibilities that current understandings do not consider. The 
conversation must continue.

So far, I have tried to show that research suggests that our biological and cultural 
evolution is not complete but ongoing, and any theory of human qualities is limited 
because it is a mere picture of the thing framed, and not the thing itself. Gardner’s theory 
of MI, having overlooked that we are evolving intellectually as well as biologically, 
discounts the possibility of ongoing individual and cultural variation, and thus is 
ontologically and epistemologically inaccurate in two significant ways. These points will 
serve as the key discussion points for the duration of this conversation.

2.4.1. Contingency in development

We have seen that Gardner’s essentialist and nativist approach to mind is both 
logically inconsistent in its approach to the role of culture and in conflict with research 
from other evolutionary frameworks that suggests generative growth is ongoing. His
presentation of mental states as “natural” or “underlying” kinds highlights this divergence. By positing mental qualities as innate or inborn, he commits himself to a dualist account of mind that does separate work from culture.

Recalling our brief introduction to Differentiated Instruction, the Ministry-mandated approach to student-centred instruction that draws on MI theory, we can see these same limitations in play. Earlier we saw that Tomlinson argued, first, that the “development of our potential is affected by the match between what we learn and how we learn with our particular intelligences” and, second, that since intelligence is fluid and not fixed, “providing children with rich learning experiences can amplify their intelligence, and denying them such richness of experience can diminish their intelligence” (Tomlinson, 1999, 18). After a discussion of the challenges presented by a more situated evolutionary perspective, we can distinguish two problematic assumptions. First, Tomlinson is suggesting that we must match our learning materials with our innate intelligences; we now have reason to suggest that this sentiment is too mired in an understanding of intelligence that comes from ‘within’ and that presupposes a fixed and given set of intelligences. Tomlinson’s second conclusion is that since intelligence is fluid and not fixed, we have the power to amplify or diminish students’ intelligence based on the quality of the learning experiences we provide. Although the suggestion of fluidity in intelligence may seem sympathetic to evolutionary concerns, we must remember the context in which she provided it—drawing on Gardner, she is borrowing his belief that intelligence is fluid to the extent that it is a fixed and predetermined part of our development. Her talk of increasing and decreasing intelligence based on our instruction serves a point—we as teachers want our students to be engaged and benefit from our
instruction—but it also misses an important point, that intelligence is also fluid to a point beyond her understanding of it. Nowhere in Gardner’s or Tomlinson’s texts is the potential for new intelligences considered. In fact, the opposite is emphasized, when Gardner notes that it is “more prudent” research to investigate what is, rather than what could be (1983, p. 36). Despite attempting to account for a more diverse account of student intelligence than IQ theory allowed, MI theory, and consequently DI, seems to have developed one that is just as uniform, and thus may have fallen into the same shortcomings they sought to overcome. In other words, whether the researcher is looking for one intelligence or eight, they are still funneling their effort, expectations, and resources into an entity that said to be fixed and predetermined.

This disparity leads to a practical problem for educators. Part of the appeal of Gardner’s position is that it’s tidy; if intelligence can be seen as a network of computational systems, it should be fairly easy to assess their occurrence in our own students and consequently build an accurate learning profile and, correspondingly, effective student-centred instruction. All this MI (and DI) promises. However, the more embedded approach to the evolution of mind, although answering logical challenges in MI theory, appears messy in comparison; students are seen as constantly subject to change and thus appear more unpredictable. How can we adequately account for contingency in student development? If a universal framework isn’t possible, how can educators ground their decisions and justify their reasoning? More centrally, if universal answers aren’t possible, what is educational science for?

I would like to address these questions in the upcoming two chapters by looking closely at one theorist’s model of evolutionary contingency—that of Charles Sanders
Peirce. In his extended approach to evolution, we may look deeper into the concept of contingency, past the mechanization that so often examined, past the selection process that has already been alluded to (that governs which adaptation will endure), to the source of the messy interrelation itself: the evolutionary concept of chance. Although the exact nature of chance is much debated (Handfield, 2012), it is still useful to talk about as part of an evolutionary process, as it highlights the unique contributions that living beings bring to their interactions. In contrast with Gardner’s more mechanistic approach, by emphasizing adaptability, Peirce’s model not only allows for change, but relies on it for its ontological and epistemological underpinnings. In this picture, both individual and society can be shown to participate in interrelated development, as chance variation and systematic growth work simultaneously and reciprocally in both the person and environment to create systems where stability is only ever temporary. I hope to make a place for more general evolutionary forms and explanations, based on chance and selection rather than determinative force alone, which is a different way of explaining the change and expression of human traits—one that we have not caught up with fully.

Gardner is not alone in the field of psychology in overlooking the contingent character of development. In fact, his interest in incorporating an evolutionary perspective into a theory of mind reflects a greater cultural interest in utilizing evolutionary studies during his time. During his career, many of his colleagues drew on evolution as a basis to explain features of our cultural heritage such as psychology (Bruner, 1972), linguistics (Chomsky, 1980; Pinker, 1997), cognition (Lakoff, 1987), and
ethics (Dawkins, 1979). This work has helped launch a more recent approach known as evolutionary psychology, which seeks to explain present mental or social traits and tendencies as the result of prior evolutionary adaptations, “not simply to discover the evolutionary causes of psychological traits, but actually to discover our psychological adaptations” (Tooby & Cosmides, 1992, in Buller, 2005b, p. 277; see also Symons, 1992; Buss, 1995). Proponents of this model are similar to Gardner in that they tend to explain present behavioural tendencies as the result of prior adaptations. Critiques of the conclusions reached by this paradigm are typically centered on the “reverse engineering” format of the theoretical framework (see Buller, 2005a) rather than the ontological underpinning of evolution itself. In other words, it is considered a methodologically unsatisfactory explanation that surviving organisms could be seen as helping us understand the “natural kinds” of the earlier organism. But it is not often considered that the evolutionary processes would offer any kind of epistemological challenge to the goals of science.

As with Gardner, if work within evolutionary psychology does not acknowledge the transactive approach mentioned above, the role of chance is discussed even less. Rather, the emphasis in this field of study is on the evolutionary reasons for the success of various mental and cultural phenomena. Although interesting, this isn’t altogether helpful when trying to navigate evolution as it occurs. As an object of investigation, chance is a topic avoided as much as possible, and this is reflected in our cultural

---


13 For example, Buss (2015) is one of the few writers in evolutionary psychology who acknowledges chance head-on, but describes such variation as a cause of dysfunction or mechanistic failure (p. 407). In such cases, chance is demonized rather than supported as a source for generative growth.
institutions (schools, assessments, and curriculum standards), which are organized to be as secure from chance, or the unexpected, as possible. Thus a conflict remains: on the one hand, chance change is, for the most part, seen as an evil to be avoided; yet, on the other hand, it is also understood to be a fundamental part of who people are. It remains to be discussed how it is possible to harmonize evolutionary beings with institutions that last and, more specifically, how to align changing natures with aims and goals in education.

2.4.2. “Unfinishedness” in science

A second and related issue is that in presenting an essentialist view of mind, Gardner is also promoting a reductivist view of the values and goals of science, which tries to explain or reduce complex phenomena, like the mind, to its most basic mechanisms. His reductivist approach also promotes a kind of determinism, as future generations are expected to follow the same mental mechanisms as the ones he studied. The search for static, universal results raises questions about the ability of scientific inquiry to accurately reflect (or adapt) with its evolving subjects of study. Notably, Gardner explicitly claimed that his focus on existing, rather than hypothesized, skills and abilities gave his research results universal credibility:

Our genetic heritage is so variegated that one can postulate all kinds of abilities and skills (as well as maladies and infirmities) that have not yet emerged, or that we have not yet come to know about. Given genetic engineering, countless other possibilities arise as well. An individual with a clever imagination might well be able to anticipate some of these
possibilities. However, it is a far more prudent research strategy to sample widely among human beings of diverse stock and to determine which competences they have in fact achieved. … The broader the sampling of human beings, the more likely that any list of the range of human intelligences will be comprehensive and accurate. (Gardner, 1983, p. 36)

Disregarding future hypotheticals may assist in clarifying research goals, however, the trade-off is that his analysis necessarily conflicts with a perspective of human beings that sees their characteristics as malleable.

Further, his claim that a “broader sampling” makes a list of intelligences more likely to be “comprehensive and accurate” takes for granted that his research question is comprehensive and accurate. However, sampling as widely across the animal kingdom as possible for “optimal” results doesn’t say anything, by itself, about the range of phenomena he is measuring, nor does it ensure that he’s asking a good question (Gould, 1981). By assuming intelligence to resemble a particular set of characteristics, he has succeeded in finding those characteristics in the animal kingdom. In other words, he found was he was looking for—but only that. Yet he will not necessarily learn more about the diversity not indicated by his very limited question. Thus, the methodology of Gardner’s study of intelligence, the very analysis that informs our current practice of student-centred, differentiated instruction, can be shown to be founded on a pursuit for objective, universalistic understanding of human nature that can be seen as limited by reductivistic thinking. Gardner’s description of how the purpose of psychological
research aims for a comprehensive account of human nature can be called into question in light of transactional accounts of mind favoured by some other evolutionary theorists.

Thus the conflict between Gardner’s theory (which is influential within education strategies in North America and other countries worldwide, and representative of other evolutionary accounts) and current perspectives in evolutionary theory, described here, concern both the study of and conclusions reached pertaining to living entities. Yet this discussion points to an educational problem larger than the values of just one instructional strategy. As mentioned, although work in the fields of biology, physics, psychology and anthropology support an evolutionary understanding of the human being that points to the importance of chance and selection, these concepts are minimally represented in the results of mind-oriented research such as educational studies and child development theory. This is not for lack of effort, however. John Dewey, one of the most well-known philosophers of education in the West, stated clearly and often that he based his pedagogical approach on the (evolutionary) principles of contingency in development and the uniqueness of each individual (1910a; 1910b; 1916). However, Dewey did not specify the place or importance of chance and variation within his theoretical structure of the teacher or learner, which may be one reason why his evolutionary underpinnings are often overlooked. Similarly, Freire (1998) discusses the importance of having “an awareness of our unfinishedness” and argues that “it is our awareness of being unfinished that makes us educable” (p. 58). However, he does not encourage us to embrace our unfinishedness but to use it, as if a tool, to achieve finishedness—“for completing our incompleteness” (Freire, 1998, p. 66). Thus, growth within education is not always

---

14 This may also perhaps be why Dewey’s philosophy of education has sometimes been used to defend somewhat reductionist methods of education, despite its antifoundational underpinnings (Cashmore, 2015).
depicted in a way that highlights evolutionary concerns; consequently, very little scholarly work exists that discusses its place and importance in the field of education.

Despite this oversight, the influence of evolution on a theory of education is of utmost significance. Building a pedagogical stance upon a theory of evolution makes the concept of change central. This has far-reaching implications in a cultural institution, such as schooling, in which many vestiges of essentialism and mechanism are found in its construction, ideals, and goals (Callahan, 1964). One area where this raises important questions is in the matter of conformity to law. To what extent do organisms, and therefore learners, follow natural laws? The conventional answer is the origin of some key assumptions in individualized instruction, but depends heavily on one’s approach to scientific investigation. As discussed, the approach taken by some current educational models relies heavily on applying mechanistic principles to psychological questions, assuming that human behaviour can be explained by unchanging laws that apply equally to everyone. These models have been criticized for borrowing so heavily from the dualism of Descartes and the mechanism of Newton (Cronbach, 1957; 1975). This approach is in conflict, however, with findings from evolutionary studies, which questions whether any fixed scheme can possibly encode all possible traits or characteristic ways of behaving. This tension is present in many currently popular models of education, specifically Gardner’s, which have adopted a computational theory of mind and in that sense view mind as a universal, abstract, and mechanizable process.

We will again look to Charles Sanders Peirce’s philosophical framework in the next two chapters for a possible solution to this tension. His semiotic approach to knowledge and inquiry relies on a system of inference and interpretation that seeks to
eliminate doubt, rather than simply compile knowledge. By drawing on a framework that also, as mentioned earlier, embraces the concepts of chance and variation, what results is a framework that, due to its flexibility, is more helpful and adaptive than what we rely on currently.

2.5. A Statement on Approach

Before moving on to a discussion of the criticisms raised, it would be helpful to clarify what I aim for the philosophical criticism of scientific research to look like. Many thinkers throughout the 19th and 20th centuries have questioned the interests of science, resisting its application or otherwise questioning its objectives, pointing to it as an attempt to master reality and or otherwise tame chance (Nietzsche, 1882, 1887; Heidegger, 1954; Arendt, 1958; Jonas, 1951, 1984; Grant, 1961, 1974, 1986; see also Hacking, 1990). Others have been more amenable to its practice, but question aspects of its epistemology due to the fact that those who stand to represent it are themselves steeped in contingencies (Kuhn, 1962, 1970; Popper, 1963, 1970; Habermas, 1968, 2003; Derrida, 1971). It is the goal of this discussion to both question the objectives of science and acknowledge the value of its tradition.

Macmillan and Garrison (1984) point out that since the Kuhnian revolution in philosophy of science, critique of science is not focused as much on individual statements, observations, and generalizations of a research program as it is on the “paradigms” (Kuhn, 1962) or “research traditions” (Lakatos, 1970) that generated that scientific work (p. 16). As such, assessment of these traditions must take a different approach than simply attempting to determine the objective truth-value of a sentence or
proposition. This is because the conclusions being critiqued “are not viewed as
discoveries about the world, but rather as decisions about how to deal with the world in
scientific investigations” (p. 16). Instead, a thoughtful critique must take into account the
methodological assumptions of the tradition it examines, and when critiquing, consider
that “decisions are not true or false, but good or bad, fruitful or (relatively) fruitless” (p. 16). In critiquing a discipline as vast and established as educational psychology, critics
would do better than simply call for its dismissal, as Macmillan and Garrison (1984)
state, “sometimes cures are better than euthanasia” (p. 15). This is a different approach
than some who are outspoken advocates of eliminating use of MI theory in schools
altogether (Willingham, 2004, 2006; Willingham & Lloyd, 2007). Therefore, it should be
stated from the outset that the purpose of this discussion is not to strip Gardner’s theory
of MI of value, but to consider the fruit it bears and evaluate the practice it helps develop
(p. 17).

As such, this discussion serves to address a different enterprise than other current
critiques of Gardner’s work. More than a few educational researchers are unhappy with
the use of psychology within education, but many point to recommendations that are as
reductivist as the problems they point out. For example, in Getting it Wrong from the
Beginning, Egan (2003) argues that educators have put excessive faith in psychological
research to improve their practices. This tradition, he argues, hails back to the work of
Herbert Spencer, who urged that an understanding of human nature would allow for
educative practices that better align with children’s innate learning needs. However, in
response, Egan calls for educators to give up seeking an explanation of human nature
overall, and instead look to the cultural and cognitive tools that actually shape behaviour.
But in doing so, Egan is exchanging one supposedly stable tool for another—cultural and cognitive tools are also things that change, and give us no better understanding of human learning. I argue we are better off going further back than simply an explanation of human nature, digging deeper still to a rationale behind the development of nature itself. Through a pragmatic stance, this will be shown to be a different enterprise than obtaining knowledge of fixed and final laws, allowing for both scientific precision and flexibility to allowing ongoing change.
Thus far, I have stated my concern for a more generalized evolutionary approach to the concept and study of mind than has been offered through the psychology of Gardner and others, arguing that the interplay of chance variation and selection is a crucial yet overlooked element in the ontology and epistemology of learning. In an attempt to capture a more generalized form of evolutionism in research and education, one that incorporates the interplay of chance and variation while respecting the goals and traditions of education and psychology, I will draw from one of the first philosophers to be strongly influenced by Darwin, Charles Sanders Peirce. Although he did not write specifically on education for young learners, Peirce hints at a compelling pedagogy that has not been adequately explored by education theorists, one that offers a hopeful vision for the teacher-student relationship while still paying close attention to empirical studies of biological and psychological phenomena. Through his theory of meaning-making, inquiry, and growth, Peirce not only acknowledges the change that occurs through evolutionary chance, but relies on it to drive the process of inquiry. I will highlight the importance of chance to these processes and show how its incorporation into theories of mind, teaching, and learning is critical to an adaptable pedagogy for living, growing beings. Peirce is known not only for being a brilliant logician, scientist, and philosopher (Fisch, 1980), but was an influential teacher to John Dewey, who applied many of his ideas (such as growth, habit, and the importance of society) to the cultural study of education. Peirce’s approach supports a view of the perceived regularity in phenomena
(such as mental states, personalities, and learning profiles) as temporary, which emerge and are continuously altered by other processes of minding such as chance and selection. Thus, his method offers a renewed approach to both the conception of mind and the conduct of science.

3.1. Review of Literature

Despite his influence on pragmatism, there is comparatively little scholarly work on Peirce’s contribution to education. Often overshadowed by the influences of James and Dewey in education (Cunningham, Schreiber, & Moss, 2005), Peirce has, however, been used to question the normative and often reductive nature of education research. For example, his emphasis on the interpretation of signs for meaning-making endorses a shift away from reductivist psychological language when talking about learners. For Strand (2013), his semiotic approach to education offers an alternative metaphor for cognition; rather than seeing cognitive processes as entities in themselves, Peirce “invites a shift in perspective from the psychological processes of learning toward the semiotic processes that characterize the production of meaning and the growth of knowledge itself” (800). Other scholars point to his potential influence for a ‘processual’ account of education. Due to his reflexive (i.e. provisional, fallible, and rectifiable) account of meaning-making, educational beliefs are presented as “a living historic entity” which can be “characterized as a mutual commitment to shared processes of joint learning” (Strand, 2005, p. 257). The processual account of pragmatism is said to be helpful in putting aside dogmatism in education (Strand, 2005; Bredo, 2009). The role and involvement of doubt within this process has also been called upon as a remedy to the ‘transmission’ model of
education; to Cunningham, Schreiber, and Moss (2005), doubt is seen as a necessary step in truly learning new beliefs, and they lament that the experimental, fallible process of abduction is “sorely neglected” in the Information Age (p. 185) where a “silver bullet” is often sought to solve all educational problems (2005, p. 186).

Despite calling for a dynamic and processual account of education, these works are not free from the challenge of mechanism. For example, Strand’s (2013) explanation of Peirce’s relevance to education as lying in his belief that “the dynamics of knowledge and learning are in the flow of signs” (p. 797) omits the crucial role of chance in generating new ideas within that flow. Similarly, Cunningham, Schreiber, and Moss’s (2005) exhortation to incorporate Peirce’s notion of experimental thought in schools, that would leave students “more able to think than when they entered” (p. 188), does not speak to the source of new ideas, or how generative thought might change the nature of a pedagogical framework. While these writers help support a processual account of educational beliefs, without an account of the role of chance to generate genuinely new ideas, they do not fully reflect the anti-essentialism Peirce also stood for. Even Gardner claimed to have framed his work as a socially-constructed understanding of intelligence modeled after Peirce’s trinary understanding of symbolic systems (Gardner, 1995b, p. 59-61), presenting the ability to make meaning through symbols as part of his mechanistic definition of intelligence. In this discussion, I would like to point out the theoretical and practical limitations of such theories that do not directly identify the role of chance in its framework of mind and intelligence.

Other accounts of Peirce’s work that do touch on more of what I hope to see in educational studies are not written for the education audience, such as Ventimiglia’s
(2008) work on the indeterminate, perpetual growth of the self, and his claim that the “appearance of maturity” does not reflect “the self in its genuine potentiality” (2008, p. 675). Works such as these that present the pursuit of a fixed end as a degenerate form of growth are describing a key element in the Peircean framework, but lack connotations for an educational and scientific framework discussed here. Further, accounts of the new or novel often overshadow its centrality to his epistemology in favor of some other feature of his cosmology, or, when it is presented as central, dismiss its relevance. Ventimiglia (2008) goes so far as to describe Peirce’s cosmology as “the least celebrated aspect of his thought” (p. 662) and “an embarrassment many Peirce scholars share” (p. 677). I believe Peirce’s incorporation of chance within his cosmology appears bizarre or “embarrassing” only from a particular understanding of the growing individual. Work in physics, evolutionary biology, and developmental systems theory in psychology have pointed to the concept of chance as not only relevant but vital to a fruitful picture of the developing being. To deny the importance of chance would be to overlook key elements in Peirce’s resistance to a purely mechanical understanding of the world.

At other times, depictions of chance are presented with the centrality they deserve, but fail to appropriately convey the dynamism involved. For example, Turley (1969) accurately describes Peirce’s theory of chance as similar to that of Epicurus, where they are “similar departures from the laws of nature” (p. 246); however, his analogy of this being like an athlete breaking out of a habit of inertia and “growing” in his capacity (p. 247-278) is not the best example to reflect the principle of chance. Although exercise is an example Peirce also uses to demonstrate that learning is like

‘exercise’ of the mind (1892), this presents growth in only a limited sense, within
biological constraints that are already determined; in a discussion of chance, however,
one can explain the emergence of new constraints or causal patterns. Turley’s example of
the athlete, intended to show that habit can be disrupted, does not explain how one grows
past themselves or their current capabilities. (Gardner’s theory of MI has already been
shown to suffer a similar limitation in its conception of growth in mental categories.) It is
for this reason I argue that examples from evolutionary biology are better suited to depict
the generative potential of chance, as this discipline is especially suited to conceptualize
the origination of newness and novelty.

This isn’t to say that educational thinkers have been entirely afraid to incorporate
conceptions of evolution into a Peircean account of education. Strand (2005) describes
Peirce’s conception of our beliefs as “evolutionary,” but uses this term as shorthand for
when “our perception of a phenomenon becomes livelier and more complex, the more
cognition we have about it” (p. 260). Nowhere here is the role of chance in generating the
novel given its proper weight. Without acknowledging the changing and evolving nature
of the phenomenon itself that the influence of chance affords, a “livelier” perception of a
phenomenon could simply mean a more detailed perception, not a changing one. This
sentiment (and challenge) extends to her approach to education as well: “Consequently,
educational beliefs should be read as relational, evolutionary entities, in that the beliefs
continuously interreact with other ideas, as they are inscribed within the educator’s
private and intellectual biographies” (p. 261). Although Strand acknowledges an
important point—that beliefs evolve in relation to others—it is not clear from this
discussion what she believes the nature of this “interreaction” to be. Are they simply
ideas that become more detailed as we learn from others, or are they beliefs that are tracing phenomena that undergo change as they interact? Thus Strand acknowledges that beliefs are changing due to being mediated, but without the precise articulation of the role of chance in this equation, a question remains of the larger picture, that is whether the whole process or environment is changing, too. Even addressing that our educational beliefs are future-oriented, continuously being constructed, and enacted in hope (p. 263) does not suitably answer this larger, evolutionary question.

Similarly, Strand (2013) points to surprise as a key element in Peirce’s account of learning, as unexpected events are the source of new ideas. Surprise, she explains, is like a “strange intruder” (p. 793) in a person’s mind when he, for a split moment, experiences a “double consciousness” (p. 794), both holding his expectations and confronting an unexpected event in his mind at the same time. Although unexpected events may initially lead to some bewilderment, as a person absorbs the new event into his understanding he learns; Strand thus contends that, to Peirce, experience is a cruel joke that may be good for us in the end.

In all the works on pedagogy that ever I read,—and that have been many, big, and heavy,—I don’t remember that any one has advocated a system of teaching by practical jokes, mostly cruel. That, however, described the method of our great teacher, Experience. She says,

Open your mouth and shut your eyes
And I'll give you something to make you wise;
and thereupon she keeps her promise, and seems to take her pay in the fun of tormenting us.

(Peirce, 1903a, p. 154; in Strand, 2013, p. 792).

Whereas I favour Strand’s reading that the new is the source of Peirce’s conception of learning, I also contend that the double consciousness is not the only, nor the central, source of learning; the role of chance has again been overlooked in this treatment. Surprise in itself does not capture the evolutionary anti-essentialism that is central to Peirce’s dynamic conception of growth; a person may conceivably be surprised in a world that runs on mechanistic tracks if he is presented with information he simply wasn’t aware of before, for example. Again, chance is a central feature in an evolutionary account of growth (though not the only feature) in this scheme, and its role and importance must be expressed.

Thus, as substantial as scholarship on his work has been, each piece comes with limitations. Thinkers have considered individual aspects of Peirce that I believe to be important to education (i.e., doubt, chance, and experience), but these considerations have always been in isolated treatments. I attempt to bring these aspects together in one sustained examination, and in doing so, hope to initiate a conversation not yet documented in Peircean studies—the role of chance in Peirce’s evolutionary epistemology toward a generative approach to student potential, an approach I call a pedagogy of change.
The role of evolutionary unfinishedness is thus a dominant driving force in the application of Peirce to education, yet this topic is profoundly overlooked in educational studies of his work. In critiquing some of the conclusions of educational neuropsychology (i.e., Gardner) from an evolutionary framework, my hope is that some discussion can help to adjust the course of this valuable field, rather than attempt to dismiss it (Macmillan & Garrison, 1984). Peirce’s theory is distinct in that science is not evaluated entirely by the knowledge it helps amass, but also by the norms guiding inquiry; it thus builds a framework that is able to critique itself by allowing one to adjust their methods in the pursuit of truth (Strand, 2005). In having norms that are themselves revisable, we get closer to a picture of evolution across all possible levels. The goal of this discussion is to stay within this Peircean framework: not to build a universal theory of education, but “to provide heuristic means for criticism of our habits” (Bergman, 2009, p. 269).

3.2. Peircean Epistemology: A Counter to the Classical Position

In order to explore the intricacies of Peirce’s theory of chance and how it fits within his wider evolutionary approach to mental life (and inquiry more generally), it is necessary to begin with his unique approach to epistemology. In this way, it grows possible to conceptualize the notions of truth, belief, and inquiry in a manner that aligns with a picture of the world as changing and in flux. The philosophical conflict addressed previously in this discussion of educational theory is very similar to the conflict Peirce himself encountered in proposing his approach to epistemology as an alternative to the foundationalism of Descartes. Educational psychology, as demonstrated in Gardner’s
work above, seeks *universal grounding* upon which it can order its tenets and recommendations, which is very similar to Descartes’ deductive approach. It was Peirce’s primary goal to overcome the epistemological foundationalism initiated by Cartesian dualism as it was found in both philosophy and inquiry. In what follows, I will explain Peirce’s suggestions on how concepts, and inquiry itself, can guide us truly while still being made of moving, growing pieces.

Peirce starts with a claim that is not all that controversial: typically, when investigating a question, one is looking for an answer. But the nature of that answer is dependent upon one’s interpretation of the concept of truth. The classical foundationalist position, defended by Descartes, claims that a true statement rests upon justified foundations of certainty, such as those built from sound premises. The history of modern Western philosophy is largely a story of how thinkers have tried to articulate the nature of this justification. Yet epistemological foundationalism was a position Peirce vehemently opposed. Two of these reasons are pertinent to this present discussion.

One critique had to do with the nature of truth. Descartes’ quest to seek the foundational truths of the universe involved using philosophical inquiry for a deeper and surer understanding of the universe than was achievable by common sense. Inspired by the certainty of the mathematical method—geometry in particular—Descartes argued that a belief’s weak foundations would make one’s whole system prone to error (Descartes, 1996, p. 17). As he wrote,

I will therefore go back and meditate on what I originally believed myself to be, before I embarked on this present train of thought. I will then subtract
anything capable of being weakened, even minimally, by the arguments now introduced, so that what is left at the end may be exactly and only what is certain and unshakeable. (Descartes, 1996, p. 25)

He thus relied on a method of deduction that traced intuitively clear and distinct principles. He first doubted all his beliefs (a process known as methodological doubt), and incrementally rebuilt his knowledge, seeing what he could know with surety. His Meditations is an attempt to see what fundamental truths followed from his first clear and distinct truth, Cogito, ergo sum, or “I think, therefore I am” (1996, p. 25).

Yet Peirce questioned how clear, distinct, and self-evident these principles and explanations could really be. Peirce argued that the foundationalist’s field of inquiry relied on an uncontested slip of terminology, that “clear” and “distinct” were terms of technical language that are themselves rather obscure. Influenced by Hume’s claim that a person does not have cognitive access to things in themselves, but only refers to them through the filter of her past experiences and beliefs, Peirce argued that we do not have access to reality itself, but only an interpretation of reality filtered by our own subjectivity.

Descartes thought this “très-clair”; but it is a fundamental mistake to suppose that an idea which stands isolated can be otherwise than perfectly blind. He professes to doubt the testimony of his memory; and in that case all that is left is a vague indescribable idea. There is no warrant for putting it into the first person singular. “I think” begs the question. “There is an idea: therefore, I
am,” it may be contended represents a compulsion of thought; but it is not a rational compulsion. There is nothing clear in it. (Peirce, CP 4.71)

This results in a much more accessible conception of philosophy, because “in philosophy, there is no special observational art, and there is no knowledge antecedently acquired in the light of which experience is to be interpreted. The interpretation itself is experience” (CP 7.527). Thus, part of his pragmatic conception of truth involves acknowledging our inquiry begins not by appealing to pure ideas, but with familiar ideas and experiences.

Peirce’s second criticism pertained to the nature of doubt and belief. To Descartes, it was possible to demolish and then incrementally rebuild knowledge with surety by first methodologically doubting all his beliefs. He builds upon the first of his foundational truths, Cogito, ergo sum, attempting to isolate the fundamental principles of the universe upon which he can confidently base his actions and beliefs. Peirce dismisses this depiction of doubt and belief as contrived and artificial, claiming that doubt is more than a mere suspension of belief. To Peirce, belief is a tendency to act as though a particular outcome is certain, such as when I walk across a floor because I believe it will hold me up. Doubt, then, is not a controlled suspension of belief that makes truer action possible, Peirce argued, but an itch or irritation that prevents action during a moment of uncertainty, as I would hesitate if I were unsure the floor would sustain my weight:

Thus, both doubt and belief have positive effects upon us, though very different ones. Belief does not make us act at once, but puts us into such a condition that we shall behave in a certain way, when the occasion arises.
Doubt has not the least effect of this sort, but stimulates us to action [investigation] until it is destroyed. This reminds us of the irritation of a nerve and the reflex action produced thereby; while for the analogue of belief, in the nervous system, we must look to what are called nervous associations—for example, to that habit of the nerves in consequence of which the smell of a peach will make the mouth water. (Peirce, 1877, p. 114)

Thus, Peirce describes the occasion of doubt out of belief as an irrepressible response, as opposed to the careful, measured process documented by Descartes. By this account, Descartes’ recount is not an instance of doubt at all: “But the mere putting of a proposition into the interrogative form does not stimulate the mind to any struggle after belief. There must be a real and living doubt, and without this all discussion is idle” (Peirce, 1877, p. 115).

The struggle to regain certainty is the process Peirce called inquiry. Beyond occurring just through the power of thought, as it did to Descartes, to Peirce inquiry was an all-encompassing affair; it might include thinking, but may also involve the use of tools or other measures to help eliminate doubt (such as how the use of a microscope might help one investigate certain questions better). Inquiry is thus, to Peirce, a process of experimentation, not purely a mode of deductive reasoning. Truth and reality, on his account, are those final ideals, reached at the end of inquiry, in which a belief is found that causes no further doubts:
The opinion which is fated to be ultimately agreed to by all who investigate, is what we mean by the truth, and the object represented in this opinion is the real. That is the way I would explain reality. (Peirce, 1878, p. 139)

However, since there is no purely deductive way to know for sure if our beliefs are true, apart from ceasing to doubt them, the aim of inquiry is simply to eliminate doubt: “With the doubt, therefore, the struggle begins, and with the cessation of doubt, it ends. Hence, the sole object of inquiry is the settlement of opinion” (Peirce, 1877, p. 114-115).

3.3. Reciprocal Constitution through Semiotics

With the lack of special observational arts or recourse to pure ideas, Peirce’s approach can feel a bit like being catapulted into deep water with no solid ground in sight. The apparent absence of access to absolute truth can seem to diminish the validity of the results of inquiry, as the doubts that lead to Peirce’s version of inquiry are considerably more provisional than that of classical foundationalism. An approach that accedes to relativism would not bode well as an antidote to foundationalism in education research, as so much is at stake that one would like to be ensured of results that are more than subjectively useful. An examination of Peirce’s theory of interpretation is necessary to demonstrate that he does not succumb to relativism. In short, Peirce’s anti-foundationalism does not amount to relativism because his account of inquiry is still goal-directed, despite starting from more provisional grounds, wherein truth is a real end to inquiry.
One of the limitations to the classical foundationalist position, according to Peirce, was that its dualist account of representations results in disputes about how the two sides are related; “But dualism in its broadest legitimate meaning…performs its analyses with an axe, leaving as the ultimate elements, unrelated chunks of being” (Peirce, CP 7.570). In response, Peirce proposes a semiotic framework in which every element of the conceptual scheme interacts to reinforce the others (this is similar to the example in evolutionary biology discussed previously, where organism and environment reciprocally constitute each other). In Peirce’s framework, representations extend beyond subject-object dualism to instead consist of three interrelated parts: a sign (also called the vehicle), an object, and an interpretant. A sign can be any signal or meaningful event (a word, image, gesture, or concept) which indicates some thing or object (real or imagined) by virtue of some of its qualities or features. The object is that thing referred to, which places constraints on the sign if it is to successfully signify the object. The interpretant is the response to the sign generated in an individual, in light of its perceived meaning or indication of what is coming next. The interpretant influences how the individual will consequently act based on the indication garnered by that interpretation. It must be noted that the interpretation is not a mere add-on to a dyadic relationship between sign and object or utterer and receiver of information; to Peirce, the sign’s meaning depends on its interpretation: “for [a sign’s] whole signification consists in its determining an interpretant; so that it is from its interpretation that it derives the actuality of its signification” (Peirce, 1904, p. 323). In other words, a sign that does not evoke a response is no sign at all.
A careful reader will note that, according to this explanation, the interpretant is not guaranteed to be an accurate depiction of the sign or object; indeed, Peirce’s theory of interpretation prohibits the interpreter from ascertaining whether or not an accurate belief has been formed by pure reasoning alone. Rather, the process of truth-building is one that relies on social interaction with others who also have doubts, wherein the inquiry community experiments, deduces, and tests results and assuages doubts together. Even the identification of objects occurs within this socially constrained space (Bergman, 2009, p. 263), where they are not just identified, but constructed through their use. This is in contrast with the starkly isolated approach of Descartes’, who believed that social input from the “common herd” would hinder the quality of his thought (Descartes, 2008, p. 32, in Cashmore, 2015, p. 151). This can seem to make the nature of truth unclear, at least, and unattainable, at most. Peirce’s position aligns somewhat with the latter reading: truth can only ever be hypothesized somewhere in the relationship of communication between a sign, object and interpretant, although there is a truth that can be aimed towards through social means. The object of the interpretation (that which is indicated by the sign) is not a reality to be reasoned toward a priori, or prior to experience, but is itself a construct developed through the process of interpretation that may become more and more refined, or less and less doubtful. For example, the sign of smoke could indicate the object of a campfire or a forest fire, but this depends both on how it is interpreted and on subsequent consequences of acting on that interpretation. What is more, the meanings of ‘forest’ and ‘fire’ also rely on interpretations and enactions of those concepts in prior experience. Although this approach to truth-seeking is more contingent than the epistemological foundationalism of Descartes, it is not merely subjective. The
interpretants still have guiding principles in the consequences of those beliefs, as they are evaluated by those consequences—whether or not the action based on the interpretation worked as the interpreter thought the sign had indicated. As mentioned earlier, to Peirce truth or reality exist as an ideal “fated to be ultimately agreed to by all who investigate;” thus truth-seeking extends beyond the inquirer, to include the community in which she is a part, and all future investigating communities, in relation with the object that is the focus of investigation. The belief developed through the interpretation not only helps to gauge the truthfulness of the interpretant but also governs the interpreter’s approach to future interpretations, as she will apply the knowledge gained to other future interpretations (Peirce, 1904, p. 314).

Interpretations successfully made once will lead to interpretations made again (Peirce, 1883-84, p. 223), so acting on signs promotes an interpretative disposition, or habit. Thus, what we typically understand as knowledge consists not of appeals to mind-independent reality, but tentatively held beliefs that can be tested and revised. The interpretation of signs can only be corroborated or contradicted by the consequent responses to the interpreter’s subsequent actions. From this approach, the beliefs a person holds are not merely mental entities to be judged as innately true or false, but are dispositional tendencies that have the character of a habit. Notably, these habits originate from a response to an occurrence of doubt, and with the instantiation of a habit that does not run into difficulty or raises any further doubts the doubt is reduced or eliminated.

The tentative approach to knowledge applies not just to concepts, but to the very act of reasoning as well. Before Peirce, building belief was largely seen as an interplay between binary forms of inference: deduction and induction. Deduction is the process by
which a conclusion necessarily follows from a set of premises and a rule, so that the conclusion must necessarily be true if the rule is followed and if all premises are true (for example, if Socrates is a man, and if as a rule all men are mortal, then Socrates is mortal). Descartes is a prime example of one who built truth by deduction; he assumed that a priori premises were true because they were innately indubitable, and “appeal to the universality of certain truths as proving that they are not derived from observation, either directly or by legitimate probable inference” (CP 2.370). Induction, often considered the inverse of deduction, is the process whereby one reasons that, given a sample of antecedent and consequent events, some rule relating antecedents and consequents must be true (for example, if it rained last Tuesday, and this Tuesday it is also raining, I may infer the rule that it rains every Tuesday). Locke is an example of one who typifies truth-building through induction, arguing that a person is limited to sensitive knowledge, or perceived properties, from which she constructs knowledge through observations and supposing one proposition to be true in virtue of another being true (CP 2.461).

Peirce devised a way for the forms of reasoning to be self-referential, too. The pre-Peirce binary of deduction and induction takes, at one time or another, rules or consequents as things to be determined. In both these cases, antecedents are always taken as given. But to Peirce, as has been shown, every event and belief must be explained, as he does not rely on a priori or other fundamental principles in his explanations. Thus he introduced the form of inference called abduction, which he defined as “any mode or degree of acceptance of a proposition as a truth, because a fact or facts have been ascertained whose occurrence would necessarily or probably result in case that proposition were true” (CP 5.603). In other words, abduction is the process by which one
reasons that, given a rule and consequent event, some antecedent may have been true. Or to put it even more simply, it is the process wherein a surprising event is made potentially non-surprising by postulating some cause for it, based on our understanding of logical rules. But this cause is a hypothesis to be tested, not a final conclusion. As Peirce explains it,

The surprising fact, \( C \), is observed.

But if \( A \) were true, \( C \) would be a matter of course.

Hence, there is reason to suspect that \( A \) is true. (CP 5.189)

In abducting fact \( A \), random or seemingly unconnected traits or ideas are put into a relationship that helps form an explanatory hypothesis (CP 5.171; CP 6.206). The end or goal of the explanatory hypothesis is, “through subjection to the test of experiment, to lead to the avoidance of all surprise and to the establishment of a habit of positive expectation that shall not be disappointed” (Peirce, 1903b, p. 235). Thus, when inferring, we no longer only wonder about the consequent of our beliefs (deduction), or the rule connecting our beliefs about antecedent and consequent events (induction), but can also speculate on the antecedent causes of a consequence or consequences. Identifying the abductive form of reasoning is important because it allows an inquirer to proceed without presupposing any fixed or unquestionable premise. By allowing inference to go between any three (rather than two) terms, Peirce can use knowledge of any two terms (antecedent, rule, or consequent) to infer the value of the third, and then use that result to infer a new value for another. By taking any two terms provisionally in order to infer the
third, an inquirer can spiral in around all three terms of inference, making successive approximations to truth without taking any of the three terms for granted or as fundamentally true (Bredo, forthcoming). In this way, one “gradually develop[s] beliefs in harmony with natural causes” (Peirce, 1877, p. 118).

Moving between three modes of inference rather than two also allows for the creation of new knowledge. Theories of understanding, which may be tested through deduction and induction, are first conceptualized through the process of abduction (CP 5.172); thus to Peirce, abduction is the first stage of inquiry.

Deduction and induction, then, come into play at the later stage of theory assessment: deduction helps to derive testable consequences from the explanatory hypotheses that abduction has helped us to conceive, and induction finally helps us to reach a verdict on the hypotheses, where the nature of the verdict is dependent on the number of testable consequences that have been verified. (Douven, 2011, para. 1)

Note that the inclusion of abduction helps assist in conceptualizing evolutionary models, too, as it allows for novel events to be incorporated into our reasoning. A novel event is a surprise without an obvious cause, and cannot simply fit into a deduction or induction when one doesn’t know enough about it to attach a rule or consequent to it. A new or surprising event tends to make one look for a cause, and fits into a scheme of reasoning only once an explanation of where that event came from can be abduced according to known rules. Further, ongoing change that results from the evolutionary
processes of random mutation and natural selection are also embraced in this model, because the rules, antecedents, and consequents are all receptive to change. The value of this third form of reasoning, therefore, is that it allows a more adaptable form of analysis than when relying on the other two (deduction and induction) alone, wherein meanings, observations, and signals may change and evolve, being evaluated on their outcomes, not simply their fit in a two-way inferential system (Bredo, forthcoming). Through the interplay of the three forms of inference, along with a willingness to be guided according to what is learned, one could be assured that her path would eventually lead to truth.

Thus it is that inquiry of every type, fully carried out, has the vital power of self-correction and of growth. This is a property so deeply saturating its inmost nature that it may truly be said that there is but one thing needful for learning the truth, and that is a hearty and active desire to learn what is true. If you really want to learn the truth, you will, by however devious a path, be surely led into the way of truth, at last. No matter how erroneous your ideas of the method may be at first, you will be forced at length to correct them so long as your activity is moved by that sincere desire. (Peirce, 1898, p. 47)

The incorporation of abduction also gives a uniquely personal approach to what is meant by “understanding.” As earlier mentioned, through Peirce’s interactional approach, we only have ideas of things as they practically affect our actions: “our idea of anything is our ideas of its sensible effect” (Peirce, 1878, p. 132). Understanding, then, is made by accepting meanings provisionally, and evaluating their truth value by both the
consequences they hold on our future action and their fit within our community of inquiry. Moving between these forms of inference also makes the pursuit of knowledge more personal and unique than the solitary, idealized quest posited by Descartes. Although a person may collaborate and test her ideas in community, the origination of those ideas is quite personalized. Existing within a unrepeatable interplay of habits, experience, and inference, a sign or belief is an individual event that can never be experienced twice (CP 5.142). Peirce states, “we are accustomed to speak of ideas as reproduced, as passed from mind to mind, as similar or dissimilar to one another”, but, “an idea once past is gone forever, and any supposed recurrence of it is another idea” (Peirce, 1892b, p. 313). In two separate states of consciousness, rising from two different sets of circumstances, they “cannot possibly be compared. To say, therefore, that they are similar can only mean that an occult power from the depths of the soul forces us to connect them in our thoughts after they are both no more” (Peirce, 1892b, p. 314).

Implications of the individuality of thought for Gardner’s more universal account of thinking will be discussed in more detail later, but for now it is sufficient to demonstrate that individualized growth and development is a central principle to Peirce’s concept of thinking; as the means, methods, and tools of our inquiry are continuously improved, so does thought continually evolve.

3.4. How to be an Antifoundationalist Without Being a Relativist

We have thus been presented with an evolutionary account of both our use of concepts and of reasoning, in which our thoughts and processes of thinking are more contingent than foundationalist explanations, but still clearly truth-directed. To restate,
concepts, or signs, are tentatively held beliefs which originate from doubts and are tested and evaluated according to whether the interpretation worked as expected. Their use (and consequently, their evaluation) relies on a moving system of inferences in which neither beliefs nor rules are held as necessarily fixed, but work together to approximate a picture of reality that reduces or eliminates doubt. Peirce’s version of realism, then, states that there are real events regulating our inquiry, but which are only accessible through a series of approximations of beliefs: “The only effect which real things have is to cause belief, for all the sensations which they excite emerge into consciousness in the form of beliefs” (Peirce, 1878, p. 137).

Thus, Peirce’s answer to the logical inconsistency of epistemological foundationalism is that an idea’s truth-value is not simply its correspondence with mind-independent reality, but rather in its ability to help us resolve doubts within our communities of inquiry. This translates into a transactional epistemology, one that aligns with beings reciprocally constituting their environments, wherein a belief is constituted and evaluated according to the practical outcome of acting upon it. Although this position is antifoundationalist, it is not relativistic. Bergman (2009) points out two reasons why. For one, in Peirce’s account, truth can be a real end of inquiry; the truth that inquirers seek is, however, shared as collective habits that stand subsequent testing (p. 256). Second, Peirce’s theory of truth is goal-directed and has practical consequences: “signs which would be merely parts of an endless viaduct for the transmission of idea-potentiality, without any conveyance of it into anything but symbols, namely, into action or habit of action, would not be signs at all, since they would not, little or much, fulfill
the function of signs” (Peirce, 1906, p. 388, in Bergman, 2009, p. 256). This results in an approach to inquiry that is fruitful, and can guide us truly, yet is open to change.

Peircean semiotics has been explored for what it could offer for the field of education. Some suggest shaping educational practices to be more keenly aware of the Peircean process of interpreting signs (Houser, 1987; Cunningham, 1987a, 1987b, 1992). In such a model of education, “students would not be taught what to think but how to think” (Cunningham, 1987b, p. 214), placing “the same significance on prediction and experimentation for all learning that is usually associated only with scientific learning” (Houser, 1987, p. 272). More specifically, Peirce’s theory of reasoning (described above as the process of abduction, induction, and deduction) is sometimes invoked to provide a model for good student thinking, either in reasoning skills generally (Chiasson, 1999, 2005) or in mathematics instruction more specifically (Danesi, 2003). However, these discussions sometimes attempt to prescribe a specific track of curriculum that emphasizes the methodology of inquiry, and in doing so foster a sense that methodological correctness, rather than collaboration, experience, and evaluation, is the way to true belief. It is an overly strong, and nearly Cartesian, conclusion that “once a learner knows how to ‘reason rightly’…that person has the potential to gain control over all purposive behaviors” (Chiasson, 1999, p. 4, emphasis in original). In other interpretations, it is concluded that certain reasoning behaviours are “innate” to the learner (Danesi, 2003, p. 80), which doesn’t correspond well with the contingent nature of developing beliefs discussed thus far. Although I support the mindful use of the Peircean approach to reasoning in the classroom, I am not convinced that prescribing specific programs of learning, or hailing particular skills as innate, is the use Peirce envisioned for his theory.
This is because the philosophical basis of his theory of reasoning makes a stronger case for antifoundationalism than has been acknowledged, which I argue prevents application-like use of his theories as has been suggested by previous writers. At the heart of his theory of reasoning (and sign use in general), is an evolutionary theory of growth that takes each scenario as new and independent, and every human characteristic (even the ability to reason itself) as tentative, temporary, and in the process of change.

Once a framework for ascertaining change has been hypothesized, which I have argued semiotics serves very well, a necessary follow-up question is how this will reflect on a research framework. Further, it has not yet been clarified what chance has to do with all this. How can chance, which is lawless, fit within a conceptual structure that claims to be scientific? In the following section, we will examine these questions through a more in-depth look at Peirce’s concept of growth.
Peirce claims that abductions are unique among the forms of inference because they are the spring from which new theories, ideas, and ways of acting, are born (CP 5.171, 5.172; Ventimiglia, 2008, p. 668). As such, Peirce’s concept of abduction is also often called upon as setting the stage for creativity and innovation, “truly original ideas” (Chiasson, 1999, p. 4) or “free play with ideas” (Strand, 2005, p. 273, see also Ventimiglia, 2008, p. 668). An element of the originality of these ideas that is not often clarified in Peirce scholarship, and in educational applications of his work especially, is that these ideas are not just new to us, but reflect and correspond with changes in truth or reality as well. Although Peirce is a realist in terms of the objects of our inquiry (which the processes of sign interpretation and inference help us approximate), it is not as though truth or reality is fixed or unchanging as it was to the foundationalists. Rather than relying on a mechanistic approach to science to understand the cosmological rules of the universe, here too Peirce applies his evolutionary framework, suggesting cosmological laws are not fixed and universal, but additional cases in which habit-taking and adaptability sometimes generate conditions for their own reproduction or reinforcement, but sometimes generate new habits or dispositions, too.

It may help to clarify this by lingering on the term generation a moment longer. When speaking of a generation, a person typically refers to a phase in the life cycle that sees the creation of successive offspring—the process of generation in this account is somewhat orderly, as the process of creating new life is reliable, straightforward, and somewhat predictable. However, closer to the Peircean account of generation is Gregory
Bateson’s example of how binocular vision is generated through the interaction of two eyes—something new (binocular vision) is created through the interaction of otherwise unrelated parts, wherein

The aggregate is greater than the sum of its parts because the combining of the parts is not a simple adding but is of the nature of a multiplication or a fractionation… (Bateson, 1979, p. 86)

This new relationship is not only contingent upon the interaction of independent parts, but also affects subsequent development of conditions, relations, and possibilities (binocular vision makes depth perception possible, for example). In this sense, it is neither determined by what came before it, nor regulated by some preexisting ultimate end.

Thus, within the interplay of signs and inference already discussed, the pursuit of knowledge consists not of a growing approximation of fixed possibilities, but further interrelates with a truth or reality that changes as well. In the pursuit of knowledge, we are grappling with moving parts at all levels. It is in this sense, then, that the creativity of abduction is more than just an exercise of the imagination as Chiasson and Strand indicated. Conceiving the result of abduction as mere creativity or “free play with ideas” does not capture the generative element of evolution, where these possibilities may not have been present at an earlier point in time, not to mention that this “play” is not so much “free” as specifically serving to resolve a tension of belief, more accurately. One reason I believe this generative element is missed is because the role of chance in habit
and abduction is so often overlooked. Despite its seemingly ephemeral and controversial nature (Handfield, 2012), the concept of chance is central to Peirce’s model of abduction. An explanation of its role can make this clearer and demonstrate its importance.

4.1. The Definition of Chance

In *A Guess at the Riddle*, in which he takes a guess at the ‘riddle of the universe’, Peirce hypothesizes an explanation of natural laws that detract from the centrality of universal, mechanical necessity. According to Peirce, mechanism is the “doctrine that all the phenomena of the physical universe are to be explained upon mechanical principles” (Peirce, 1891, p. 287). A consequence of the mechanist approach is necessitarianism, which states “that certain continuous qualities have certain exact values” (Peirce, 1892a, p. 303). Peirce credits the discovery of mechanics with “the hope that mechanical principles might suffice to explain the universe” (Peirce, 1892a, p. 299), a hope that pervades the study of mind today (Cronbach, 1957; 1975).

Mechanical necessity approaches chance as though it were an aberration of thought, an illusion or misunderstanding. By this approach, chance is not just impossible to explain, but is nonexistent if one understands things in a mechanistic way. This way of thinking presents a problem when talking about evolution, because mechanical necessity does not admit of change. For change to occur, as Epicurus noted, there must be some kind of ‘swerve’ (Peirce, 1892a, p. 298), of which mechanism cannot give an account. Peirce acknowledges that regularity or mechanical necessity is a factor in development, and that we have some predisposition to see the regularity in phenomena around us: “Thus it is that our minds having been formed under the influence of phenomena
governed by the laws of mechanics, certain conceptions entering into those laws become implanted in our minds, so that we readily guess at what the laws are” (Peirce, 1891, p. 287). However, he argues that if we look closely at the kinds of problems we seek answers for, we find that we are actually quite selective in the phenomena we try to explain, and are happy to do so. For example, he says, if all the grains of sand on a beach separated themselves into distinct groups, with those of more spherical shapes separate from those of more cubical shapes, we would consider this a phenomenon to be explained. Or if all births took place on only one day of the week, we would search for an underlying cause. But because sand rests in no definable manner, and because births are scattered in equal proportion throughout the week, these scenarios call for no particular explanation.

In other words, we do not try to explain coincidence. Coincidence seems to lay outside the scope of our explanations. We betray our bias, Peirce argues, when we seek to explain causes, because we only do so when regularities have been brought to the forefront: “Indeterminacy affords us nothing to ask a question about…But every fact of a general or orderly nature calls for an explanation” (Peirce, 1887-88, p. 274). We do this even though, as his examples show us, regularities do not make up the whole story. But from Peirce’s perspective, uniformities are the puzzling anomaly, rather than the other way around; uniformity, not chance, is the thing to be explained.\footnote{In an educational context, this could be seen as similar to a conclusion on reading behaviours drawn by Immordino-Yang and Deacon (2007), that from an evolutionary perspective, it is not learning disorders that stand out as deviant from the norm, but rather the ability to read in itself.}

To suppose universal laws of nature capable of being apprehended by the mind and yet having no reason for their special forms, but standing
inexplicable and irrational, is hardly a justifiable position. Uniformities are precisely the sort of facts that need to be accounted for. (Peirce, 1891, p. 288)

Causal mechanics can explain regularity, but as Peirce points out, it is not necessarily the most pervasive factor in the world; we only pay attention to it more. Another example he uses is the scenario of rolling a pair of dice. The law of mechanical necessity may determine which number is rolled. But, Peirce asks, how do we explain the difference between rolling sixes and rolling any other number? Peirce points out that the laws of mechanism explain very little of this question: the same causal, mechanistic laws are responsible for both rolling sixes and rolling other numbers. In other words, causal mechanics does not do a very good job of explaining the diversity of experiences:

But it appears to me that it is not these laws which made the die turn up sixes; for these laws act just the same when other throws come up. The chance lies in the diversity of throws; and this diversity cannot be due to laws which are immutable. (Peirce, 1892a, p. 307)

Suggesting, as Peirce’s imaginary interlocutor did, that “the intrinsic complexity of the system is the same at all times” (Peirce, 1892a, p. 307), does not explain what makes one throw different from another. Diversity or irregularity, Peirce argues, is something that mechanistic philosophy cannot explain very well at all.
These chance occurrences, or coincidences, actually make up a significant portion of perceived phenomena. In fact, Peirce argues that we leave more phenomena \textit{unexplained} than explained. He says,

"We enormously exaggerate the part that law plays in the universe. It is by means of regularities that we understand what little we do understand of the world, and thus there is a sort of mental perspective which brings regular phenomena to the foreground. We say that every event is determined by causes according to law. But apart from the fact that this must not be regarded as absolutely true, it does not mean so much as it seems to do. We do not mean, for example, that if a man and his antipode [someone on the exact opposite side of the globe] both sneeze at the same instant, that event comes under any general law. That is merely what we call a coincidence. But what we mean is there was a cause for the first man’s sneezing, and another cause for the second man’s sneezing; and the aggregate of these two events make up the first event about which we began by inquiring. The doctrine is that the events of the physical universe are merely motions of matter, and that these obey the laws of dynamics. But this only amounts to saying that among the countless systems of relationship existing among things we have found one that is universal and at the same time is subject to law. There is nothing except this singular character which makes this particular system of relationship any more important than the others. From this point of view, uniformity is seen to be really a highly exceptional phenomenon. But we pay
no attention to irregular relationships, as having no interest for us. (Peirce, 1887-88, p. 276, emphasis added)

That spontaneity is more prevalent than law Peirce repeats in another work as well; “exact law obviously never can produce heterogeneity out of homogeneity; and arbitrary heterogeneity is the feature of the universe the most manifest and characteristic” (Peirce, 1891, p. 289).

Coincidence seems to lay outside the scope of natural law, but Peirce argues this is unsatisfactory for a supposedly universal scheme of explanation: “The mechanical philosopher leaves the whole specification of the world utterly unaccounted for, which is pretty nearly as bad as to boldly attribute it to chance” (Peirce, 1892a, p. 310). Rather than leaving it inexplicable, Peirce suggests coincidence may have more to do with natural law than is typically supposed. We have already discussed the occasion of regular, law-like relationships in the discussion of the development of interpretive habits; as we discussed it, acting on signs (interpretations) promotes an interpretative disposition to develop, so that action taken once is more likely to lead to action taken again. The same concept Peirce applies to a yet higher level of meta-analysis, that is, to cosmological laws themselves. To Peirce, natural law is not the primary, universal building block of the universe, but can be explained as a habit of interaction that is also subject to coincidence.

…all things have a tendency to take habits. For atoms and their parts, molecules and groups of molecules, and in short every conceivable real
object, there is a greater probability of acting as on a former like occasion than otherwise. This tendency itself constitutes a regularity, and is continually on the increase. In looking back into the past we are looking towards periods when it was a less and less decided tendency. But its own essential nature is to grow. It is a generalizing tendency; it causes actions in the future to follow some generalization of past actions; and this tendency is itself something capable of similar generalization; and thus, it is self-generative. We have therefore only to suppose the smallest spur of it in the past, and that germ would have been bound to develope [sic] into a mighty and over-ruling principle, until it supersedes itself by strengthening habits into absolute laws regulating the action of all things in every respect in the indefinite future. According to this, three elements are active in the world, first, chance; second, law; and third, habit-taking. (Peirce, 1887-88, p. 277)

Two elements of this quote are especially pertinent. First, Peirce is indicating that chance or coincidence is the seed out of which laws and habits grow. In other words, the element of coincidence may not seem very significant, but chance occurrences are the events that have the potential to create new habits or laws. What he is proposing is groundbreaking and antithetical to mechanism: he is not suggesting that out of law some element of chance exists, but rather that out of chance, some element of law comes to exist. In this respect, Peirce’s approach to cosmological law is eliminative, rather than accumulative. Just as he described knowledge as a habit that passed repeated testing, so too is natural law, such as the law of gravity, a habit or disposition of interaction that has canalized to a
point that it creates the conditions for its own reproduction, much as water will dig a riverbed and increase the likelihood that future rainfall will deepen it further. In other words, it is eliminative in that these conditions are not incrementally built on universal foundations, but rather that some pathways of potentiality fall away as habits grow stronger. In this way, it is not only laws that develop, but objects as well; this contingent formulation serves, for Peirce, as an evolutionary account of ‘things’ or objects.

Pairs of states will also begin to take habits, and thus each state having different habits with reference to the different other states, will give rise to bundles of habits, which will be substances. Some of these states will chance to take habits of persistency, and will get to be less and less liable to disappear; while those that fail to take such habits will fall out of existence. Thus, substances will get to be permanent. In fact, habits, from the mode of their formation necessarily consist in the permanence of some relation, and therefore on this theory, each law of nature would consist in some permanence, such as the permanence of mass, momentum, and energy. In this respect, the theory suits the facts admirably. (Peirce, 1887-88, p. 279)

But on this approach, even the principle of causation is not fundamental, as it, too, owes its generation out of chance; “the argument is quite against the absolute exactitude of any natural belief, including that of the principle of causation” (Peirce, 1892a, p. 306).

The second important point pertains to the similarity between mental and natural phenomena just discussed. That the rule of habits permeates both the mental and natural
aspects of Peirce’s cosmology is why Turley (1969) refers to this as a “hylopathic” cosmology – the same rules that apply to mind apply to the universe (p. 247). Indeed, to Peirce, things are living, growing realities, as living as mind itself.

these general ideas are not mere words, nor do they consist in this, that certain concrete facts will every time happen under certain descriptions of conditions; but they are just as much, or rather far more, living realities than the feelings themselves out of which they are concreted. And to say that mental phenomena are governed by law does not mean merely that they are describable by a general formula; but that there is a living idea, a conscious continuum of feeling, which pervades them, and to which they are docile.

(Peirce, 1892b, p. 330)

A hierarchy is thus developed, as law cannot be self-explanatory, but must rely for its genesis on chance:

We are brought, then, to this: conformity to law exists only within a limited range of events and even there is not perfect, for an element of pure spontaneity or lawless originality mingles, or at least, must be supposed to mingle with law everywhere. Moreover, conformity with law is a fact requiring to be explained; and since Law in general cannot be explained by any law in particular, the explanation must consist in showing how law is
developed out of pure chance, irregularity and indeterminacy. (Peirce, 1887-88, p. 276).

For this reason, he says that “Chance is First, Law is Second, the tendency to take habits is Third” (Peirce, 1891, p. 297). In fact, Peirce captures his entire approach as a model of ones, twos, and threes:

First is the beginning, that which is fresh, original, spontaneous, free. Second is that which is determined, terminated, ended, correlative, object, necessitated, reacting. … A thing which in any way brings one thing into relation with another is a third or medium between the two. (Peirce, 1888, p. 280)

We have already encountered the concept of thirdness in our discussion of meaning making, where interpretation mediates between a sign and an object. That process of interpretation is thirdness, which is the bringing in of relationship between two things. Secondness, in Peirce’s account, is that which is governed by causal, mechanical relationships. These habits are so deeply canalized that their relationship is one of necessity. Firstness is that which comes before any semblance of cause. In the split second before a cause, or registered emotion, there is simply an inarticulate feeling.

It should be noted that chance alone cannot account for the universe, because chance alone would only involve pure spontaneity without order. For there to be order requires causation. This is how Peirce hypothesized the structure of the universe, as
commencing with a chance occurrence, leading to some crystallization of habit, and eventually evolving thinking agents that try to make sense of it all\textsuperscript{17}.

Our conceptions of the first stages of the development, before time yet existed, must be as vague and figurative as the expression of the first chapter of Genesis. Out of the womb of indeterminacy we must say that there would have come something by the principle of firstness, which we may call a flash. Then by the principle of habit there would have been a second flash. Though time would not yet have been, this second flash was in some sense after the first, because resulting from it. Then there would have come other successions ever more and more closely connected, the habits and the tendency to take them ever strengthening themselves, until the events would have been bound together into something like a continuous flow. … Different flashes might start different streams, between which there should be no relations of contemporaneity or succession. So one stream might branch into two, or two might coalesce. But the further result of habit would inevitably be to separate utterly those that were long separated, and to make those which presented frequent common points coalesce into perfect union. Those that were completely separated would be so many different worlds which would know nothing of one another; so that the effect would be just what we actually observe. (Peirce, 1887-88, p. 278)

\textsuperscript{17} Note that this also allows flexibility in terms of adaptation to currently debated theories about the origin of the universe. Peirce’s hypothesis of the formation of habit since the infinitely remote origin of the universe remains valid whether you hold to the Big Bang theory (Lemaître, 1927) or believe the universe originated before that (Feeney, Johnson, Mortlock, & Peiris, 2011).
Peirce’s approach to chance and order does not prevent the use of mechanical laws, but does change our conception of them. Mechanical laws alone cannot account for the ongoing diversification we have been concerned with here. This is because regularity serves only to recreate versions of itself (Peirce, 1891, p. 289). Thus, considering mechanism as the primary principle of the universe frames our approach as one of necessity, and either “denies without any evidence or reason the existence of this spontaneity” or “shoves it back to the beginning of time and supposes it dead ever since” (Peirce, 1892a, p. 308), presuming all the building material of the world is already there. But Peirce’s hypothesis allows for the possibility of evolution by allowing ongoing diversification to take place. This is the greatest departure between Peirce and mechanical necessitarianism.

You think all the arbitrary specifications of the universe were introduced in one dose, in the beginning, if there was a beginning, and that the variety and complication of nature has always been just as much as it is now. But I, for my part, think that the diversification, the specification, has been continually taking place. (Peirce, 1892a, p. 307)

Besides, variety is a fact which must be admitted; and the theory of chance merely consists in supposing this diversification does not antedate all time. Moreover, the avoidance of hypotheses involving causes nowhere positively known to act—is only a recommendation of logic, not a positive command. It
cannot be formulated in any precise terms without at once betraying its untenable character,—I mean as rigid rule, for as a recommendation it is wholesome enough. (Peirce, 1892a, p. 310)

4.2. The Role of Chance in the Study of Mind

As a result of making room for ongoing diversification, Peirce argues that his hypothesis allows for the possibility of genuine inquiry in a way that necessitarianism precludes. By “loosening the bond of necessity” as Peirce has done, we have made “room for the influences of another kind of causation”, which is chance (Peirce, 1892a, p. 308). Peirce argues that doing so allows for the insertion of a phenomenon that mechanical necessity would have omitted—and that is mind. Mind, as discussed earlier, exists as a mode of functioning that creates meaning through interpreting signs, inferring, and testing beliefs in an attempt to resolve doubt and attain goals18. Peirce states, “Intellectual power is nothing but facility in taking habits and in following them in cases essentially analogous to but in non-essentials widely remote from, the normal cases of connections of feelings under which those habits were formed” (Peirce, 1891, p. 291). In a strictly mechanized world, Peirce argues, there would be no doubt and thus no need to test; mind would have no role, and therefore wouldn’t exist.

18 This is a hugely anthropocentric way of describing mind, but seems necessary for the discussion at hand. However, consider earlier that Peirce’s approach is considered “hylopathic,” in that his rules apply equally to mind and the universe; in this way, Peirce’s concept of mind was not limited to human thinking. Consider how plants and animals also demonstrate mind by ‘interpreting’ signals around them behaviourally, adapting their courses of growth according to environmental changes. See Bateson, 1979, Chapter 4: Criteria of Mental Processes, for a thorough discussion on how the process of ‘minding’ can be seen throughout nature.
But no mental action seems to be necessary or invariable in its character. In whatever manner the mind has reacted under a given sensation, in that manner it is the more likely to react again; were this, however, an absolute necessity, habits would become wooden and ineradicable, and no room being left for the formation of new habits, intellectual life would come to a speedy close. Thus, the uncertainty of the mental law is no mere defect of it, but is on the contrary of its essence. The truth is, the mind is not subject to ‘law,’ in the same rigid sense that matter is. It only experiences gentle forces which merely render it more likely to act in a given way than it otherwise would be. There always remains a certain amount of arbitrary spontaneity in its action, without which it would be dead. (Peirce, 1892b, p. 329)

Mind, like natural laws, is not, according to this reading, hard and fast sets of rules, pure and universal and to be objectively understood as dualists like Descartes and Gardner claimed they could. Rather, it is a kind of coordination that bridges chance and regularity.

The law of habit exhibits a striking contrast to all physical laws in the character of its commands. A physical law is absolute. … On the other hand, no exact conformity is required by the mental law. Nay, exact conformity would be in downright conflict with the law; since it would instantly crystallise thought and prevent all further formation of habit. (Peirce, 1891, p. 292)
Seeing mind in this way, in which it not only directs but shapes the conditions of its existence, offers a way out of Cartesian dualism, and also the dualism Gardner committed to when he visualized the mind as discrete and innate computational functions. Rather, by Peirce’s account, mind shapes and constitutes the conditions of its existence.

On the other hand, by supposing the rigid exactitude of causation to yield, I care not how little,—be it but by a strictly infinitesimal amount,—we gain room to insert mind into our scheme, and to put it into the place where it is needed, into the position which, as the sole self-intelligible thing, it is entitled to occupy, that of the fountain of existence (Peirce, 1892a, p. 309)

Peirce’s hypothesis on the nature of chance and law aligns well with the problems of mind that has been discussed thus far. Peirce acknowledges the contingency of mental and natural phenomena by showing how they are necessarily temporal.

personality is some kind of coördination or connection of ideas. … This personality, like any general idea, is not a thing to be apprehended in an instant. It has to be lived in time; nor can any finite time embrace it in all its fulness [sic]. (Peirce, 1892b, p. 331)

There is a danger in presenting mind and nature as a kind of coordination, which is that the concept of coordination is so commonly linked with mechanical necessity that the very word can imply a regularity that is not intended. As Peirce notes, “But the word
coördination implies somewhat more than this; it implies a teleological harmony in ideas” (Peirce, 1892b, p. 331). The danger of this is that it can further imply predeterminate aims or goals, when none such exist. In Peirce’s account, however, the mind creates its aims or goals in the process of bridging past experiences with present actualities. If no two experiences will ever be exactly the same, it means that no matter how closely aligned a set of experiences are, there can never be universal aims. Thus, Peirce’s teleology is one where all phenomena are living, always in a state of flux, according to their own, uniquely generated, habits. As an active agent in the development of habit and laws, mind would be “brought to a speedy close” (Peirce, 1892b, p. 329) if a mechanical universe were in fact in place because as a skill it would be redundant. “Thus, the uncertainty of the mental law is no mere defect of it, but is on the contrary of its essence.” (Peirce, 1892b, p. 329).

Such a temporal view of mind forms Peirce’s unique developmental teleology, which states that an action or thought is determinative to a point, but to an extent to which it is not fully aware:

in the case of personality this teleology is more than a mere purposive pursuit of a predeterminate end; it is a developmental teleology. … A general idea, living and conscious now, it is already determinative of acts in the future to an extent to which it is not now conscious. … Were the ends of a person already explicit, there would be no room for development, for growth, for life; and consequently there would be no personality. The mere carrying out of predetermined purposes is mechanical. It is that a genuine evolutionary
philosophy, that is, one that makes the principle of growth a primordial element of the universe. (Peirce, 1892b, p. 331, emphasis added)

As such, Peirce has a future-oriented approach to the development of human thinking in which both our beliefs and possibilities for action grow in a transactive relationship with the world. Because beliefs provide the guide for action, Peirce calls a belief or idea an “embryonic reality” (Peirce, 1904, p. 324) to the extent that it in part determines the future as it “governs…individuals, and prescribes some of their qualities” (Peirce, 1903c, p. 274). Ideas and organisms experience change over time due to the influence of this “two-part process of determination and correction” (Peirce, 1904, p. 324). Thus, this evolutionary structure of all elements of the cosmos grounds the framework of Peirce’s entire epistemology (Ventimiglia, 2008), as “everywhere the main fact is growth and increasing complexity” (Peirce, 1892a, p. 308). This is much different than Descartes’ foundationalist principles, and it also contrasts with the universalistic, innate theory of intelligence proffered by Gardner and our education system.

4.3. Implications of a Developmental Teleology for the Sciences

This evolutionary approach to philosophy and inquiry, which “makes the principle of growth a primordial element of the universe” (Peirce, 1892a, p. 331), has significant consequences for how a person approaches mental and physical phenomena. If laws and ways of acting are built from random occurrences, there is a real sense in which our world springs from the random, as “the generalizing tendency builds up new habits from chance occurrences” (CP 6.206). Yet the rule of the law is used to explain and
prescribe a vast majority of processes and phenomena in the world, including in education. One of Peirce’s key goals for philosophy was to show that, to borrow Peirce’s phrase, the hand of the law has been exaggerated. Peirce’s unique and insightful move has been to identify the role of chance in laws and habits. He argues that the order of the universe is not created by fixed laws, or synonymous with them, as many theories attest, but that first comes chance, then law, then our sense of meaning.

However, the dominant approach to educational science today is as though the world runs like a machine, as though “every event in the universe is precisely determined by causes according to inviolable law” (Peirce, 1887-88, p. 273). Yet Peirce argues that the postulates advanced under this pretext are difficult to trust as means to truth. One reason is because of the nature of postulates—they are hypotheses and as such make no pretension to any knowledge other than that. By inferring, we simply mean that we take our experience now to apply to other experiences and at other times, but “can at most only suppose something to be most frequently, or otherwise approximately, true, but never that anything is precisely true without exception through the universe” (Peirce, 1892a, p. 300). Through these inferences, Peirce suggests we cannot speculate about the nature of things-in-themselves, as our observations concern only the matter of possible experience.

For what is a postulate? It is the formulation of a material fact which we are not entitled to assume as a premise, but the truth of which is requisite to the validity of an inference. Any fact, then, which might be supposed postulated,
must either be such that it would ultimately present itself in experience, or not. (Peirce, 1892a, p. 301-302)

Additionally, whereas these postulations may indicate that there is some regularity in nature, they cannot have any bearing on the question of whether or not such regularity is universal (Peirce, 1892a, p. 301).

In fact, Peirce argues, the laws we hypothesize are categorically difficult to observe in practice. In laboratories and scientific fieldwork, he explains, measurements that are obtained, no matter how carefully taken, do not map with complete precision or uniformity, as there is always error around a predicted mean; rather, we get a distribution of results that are interpreted according to their alignment with an apparent regularity19.

Those observations which are generally adduced in favor of mechanical causation simply prove that there is an element of regularity in nature, and have no bearing whatever upon the question of whether such regularity is exact and universal, or not. Nay, in regard to this exactitude, all observation is directly opposed to it; and the most that can be said is that a good deal of this observation can be explained away. Try to verify any law of nature, and you will find that the more precise your observations, the more certain they will be to show irregular departures from the law. (Peirce, 1892a, p. 304-305)

---

19 It was Peirce who gave the modern understanding of the term “normal” to the bell-shaped distribution of probabilities (CP 6.327).
Scientists and mathematicians who preceded Peirce acknowledged differences between measured and theoretically expected values but attributed this to measurement error. However, as explained, to Peirce this claim remained logically unfounded, as it is impossible to tell whether the error is due to a problem in measurement or a theoretical problem in the belief in mechanism and determinism. Instead, he points to another explanatory factor within science—that of chance as it is found in probability (Peirce, 1892a, p. 305). The looseness or flexibility of measurement, he suggests, may not be just a byproduct of humankind’s limited power of observation, but also the evolving universe being transformed by chance.

Now the only possible way of accounting for the laws of nature and for uniformity in general is to suppose them results of evolution. This supposes them not to be absolute, not to be obeyed precisely. It makes an element of indeterminacy, spontaneity, or absolute chance in nature. (Peirce, 1891, p. 288)

If the role of chance has been sufficiently defended as a valid hypothesis of cosmology, then the mechanistic inquirer has left a significant portion—possibly even the greater portion—of the universe unaccounted for. She has ignored the existence of non-mechanistic phenomena as well as the source of perceived regularities (Peirce, 1892a, p. 310).

Relatedly, this discussion offers an alternative hypothesis for how scientific theories are formed, one that is more receptive to disciplines that try to acknowledge and
incorporate a world seen so profoundly influenced by chance, such as non-linear
dynamics, quantum physics, and chaos theory. By this approach, a world run by chance is
constantly subject to change; be these changes infinitesimal, they still signify that no
structure, law, or idea is integral to the overall configuration. This suggests that no matter
how precise or finely-tuned our scientific apparatus, the results of scientific inquiry offers
a mere snapshot of a process that may be dynamic and still evolving. This questions the
capacity of research, and raises a challenge for theorists who seek universal answers,
including those in fields such as psychology and education studies. As Cronbach was
earlier quoted as saying, investigation can still be useful in providing concepts and tools
with which we can more intelligently navigate our environments (1975, p. 126). This still
stands; concepts, tools, methods, and past experiences add to the inquiry we engage in to
resolve our doubts. But Peirce’s “thorough-going evolutionism” (1891, p. 289) calls for a
change in our approach and expectations in scientific inquiry—to be tentative and
cognizant of change. Peirce keeps to this belief very well, never insisting his version of
evolutionism is an incontrovertible law, but rather a recommendation or suggestion of
logic:

Besides, variety is a fact which must be admitted; and the theory of chance
merely consists in supposing this diversification does not antedate all time.
Moreover, the avoidance of hypotheses involving causes nowhere positively
known to act—is only a recommendation of logic, not a positive command. It
cannot be formulated in any precise terms without at once betraying its
untenable character,—I mean as a rigid rule, for as a recommendation it is wholesome enough. (Peirce, 1892a, p. 310)

Thus, it must be remembered that Peirce’s approach is just that—an approach, not a definitive notion. We cannot instantiate these ideas themselves as absolute laws if we acknowledge that, as Peirce has shown, we can only approximate those laws via experience. But it is an approach that can be tested and evaluated for its value to the greater community of inquiry. One key value, according to Peirce, is that it frees us from the hopelessness of determinism that stems from absolute laws, wherein our actions have no meaningful effect in changing things from their predestined ends. Instead, by believing in chance, Peirce argues, we can be guided by optimism, rather than finality: “We must therefore be guided by the rule of hope, and consequently we must reject every philosophy or general conception of the universe, which could ever lead to the conclusion that any given general fact is an ultimate one” (Peirce, 1887-88, p. 275).
CHAPTER 5 – Implications for Educational Theory

I have tried to demonstrate that Peirce’s transactive, processual-oriented approach to thinking and belief is a viable alternative to the universal foundationalism of Gardner’s approach to intelligence. Connections thus far have been made between philosophy of education and other disciplines such as evolutionary biology, philosophy of physics, and clinical psychology. But, as Peirce demonstrated, the story is not complete as there is always room for further growth so long as questions linger. How we employ Peirce’s evolutionary framework is limited only by our inquiries.

5.1. Epilogue

In literature, an epilogue is a short final passage that details the fate of its story’s characters. It may be fitting to conclude our discussion with a brief note on how the character of this story, Peirce’s evolutionary model, was extended in the work of his student, John Dewey. Like Peirce, Dewey argued that all life events or experiences included external and internal components aspects that were interrelated to a point of being inseparable in practice; “The word ‘interaction’…assigns equal rights to both factors in experience—objective and internal conditions. Any normal experience is an interplay of these two sets of conditions. Taken together, or in their interaction, they form what we call a situation” (Dewey, 1938a, p. 42, emphasis in original). Our ‘internal conditions’ consist of the beliefs or attitudinal tendencies through which we interact with the world; “it covers the formation of attitudes, attitudes that are emotional and intellectual; it covers our basic sensitivities and ways of meeting and responding to all the
conditions which we meet in living” (Dewey, 1938a, p. 35). The ‘objective conditions’ are those events which impress upon us and modify our habits or beliefs: “every experience enacted and undergone modifies the one who acts and undergoes, while this modification affects, whether we wish it or not, the quality of subsequent experiences. For it is a somewhat different person who enters them” (Dewey, 1938a, p. 35). Dewey helped extend Peirce’s ideas to demonstrate their importance to an understanding of social life. Here especially we see the social implications for Peirce’s theory of chance, that “reality is transformed by means of validation—so that our desires and ideas both direct and become real forces in the world, affecting the formation of the reality that results” (Chiasson, 1999, p. 2).

In Dewey’s extended approach, when life experiences impress or modify our beliefs, we enact our renewed beliefs back onto the world, which creates new experiences that affect us in return. Thus, our changed attitudes and approaches help create new experiences (in conjunction with the environment), which act upon us in a feedback loop:

From this point of view, the principle of continuity of experience means that every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after. (Dewey, 1938a, p. 35)

And again,
As we have seen, there is some kind of continuity in any case since every experience affects for better or worse the attitudes which help decide the quality of further experiences, by setting up certain preference and aversion, and making it easier or harder to act for this or that end. (Dewey, 1938a, p. 37)

But further, and correspondingly, each experience alters the objective conditions as well:

Moreover, every experience influences in some degree the objective conditions under which further experiences are had. For example, a child who learns to speak has a new facility and new desire. But he has also widened the external conditions of subsequent learning. When he learns to read, he similarly opens up a new environment. If a person decides to become a teacher, lawyer, physician, or stockbroker, when he executes his intention he thereby necessarily determines to some extent the environment in which he will act in the future. He has rendered himself more sensitive and responsive to certain conditions, and relatively immune to those things about him that would have been stimuli if he had made another choice. (Dewey 1938a, p. 37)

Any experience, according to Dewey, is an interplay between these two sets of conditions (Dewey, 1938a, p. 42). Not only this, but as was the case for Peirce, organism and environment help to define one another. As the above quote shows, to Dewey, what
constitutes an “environment” depends on the organism, and what it perceives and responds to.

Those familiar with Dewey’s larger philosophical works may see how this interplay of acquired habits extends his description of the renewal of society depicted in Chapters 1 and 2 of Democracy and Education. There, he describes the reproduction of social life as occurring through transmission across generations:

Society exists through a process of transmission quite as much as biological life. This transmission occurs by means of communication of habits of doing, thinking, and feeling from the older to the younger. Without this communication of ideals, hopes, expectations, standards, opinions, from those members of society who are passing out of the group life to those who are coming into it, social life could not survive. (Dewey, 1916, p. 3)

However, in this extended reading furnished by the discussion of Peirce’s work, it is suggested that in creatively engaging with our available conditions, we have the power to add to our culture, or change our form of social life. Dewey points out that despite the direction of the older members of society, “purely external direction is impossible” in that “the environment can at most only supply stimuli to call out responses” (1916, p. 25), responses that only the younger members can furnish themselves. But as with the biological condition of evolution, the fact that social traits are passed down does not mean the next generation will necessarily be the same. In the process of meeting the
conditions of the environment, cultural or otherwise, each member may solve their inquiry in a manner that adds to the conditions of social life.

In providing an example, Dewey asks his reader to consider the difference between living “in the wild” and living “in civilization;” civilization, he argues, consists not only of choosing to live in a certain way, but is made possible through the formation of things such as laws, roads, and tools—concepts and entities that did not exist when we lived in the wild (Dewey 1938a, p. 39). Just as in Peirce’s formulation, these things were only latent possibilities prior to creating them, but depended on the inquiry of a thinking agent, or simply changing habits, to be cultivated. In this way, we can see that culture evolves in a manner analogous to human evolution itself, where through the act of altering our social and physical environments (thereby changing our habits), we can grow past ourselves and substantively change who and what we are. Our examination of Peirce’s theory of chance helps illuminate more clearly how this process relies on factors that foster this growth in the growing cosmos itself.

Like Peirce, Dewey’s approach to evolution is one that does not just encapsulate social phenomena, but the greater cosmology as well. The greater lesson, besides gaining an appreciation for the evolution of social and cultural life, is recognizing the influence that meaning-making has in constituting nature. In engaging and broadening our conditions, we augment more than just ourselves but nature itself as we instigate new kinds of properties or relations in nature. For example, before there were humans, we may assume the sun never had the property of inspiring worship. However, that became a real, objective property of the sun once humans started engaging it in that way. Further, by engaging with the sun in this way, humans also started to construct buildings,
customs, and ways of life that adjusted other elements of nature in response that wouldn’t have been affected without that initial habit. This example suggests that even physical objects in nature can gain new properties through human social action. However, these properties are not independent of the existence of humans; like Walsh’s example of the porpoise and paramecium, organism and environment serve to constitute each other. Similarly, as in Bateson’s example of the development of binocular vision, this augmentation is not to be seen as a strictly human capability, but one that is common to any organism in active engagement with its environment; the development of three-dimensional vision presumably made available new options for living and hunting not previously possible across the plant and animal kingdoms.

The use of the term ‘augment’ to describe the change undertaken by organisms is not to be read as though evolution occurs in a strictly progressive or beneficial manner. Sometimes developments occur that are value-neutral or even harmful to the being at hand; “Other things being equal (which is not often the case), the old, which has been somewhat tested, is more likely to be viable than the new, which has not been tested at all” (Bateson, 1979, p. 177). Rather, the term is intended to be used in its capacity to express the accumulation of new features, for good or bad. I choose to emphasize this because it seems so often overlooked when considering human qualities, as I have attempted to show in Gardner’s limited depiction of the growth of the mind. As it was for Peirce, for Dewey, the potential of the universe was not established at its origins, but various phenomena (both natural and social) gained new properties through the interrelation of its various players. Dewey is exploring more than a mere symmetry, wherein humans are said to evolve and contribute to their evolving qualities in a manner
similar to nature, where the processes of physical development are also dispositions that have developed over time. Rather, Dewey is exploring an interrelation, arguing that our social practices may change nature itself by creating new causal relationships, even giving “physical” objects new properties.

This, to Dewey, has significant implications on the ontology and teleology of topics, ideas, and concepts presented in educational contexts, as:

That which is taught is thought of as essentially static. It is taught as a finished project, with little regard either to the ways in which it was originally built up or to changes that will surely occur in the future. It is to a large extent the cultural product of societies that assumed the future would be much like the past, and yet it is used as educational food in a society where change is the rule, not the exception. (Dewey 1928, p. 19)

Considering the evolutionary limitations of our educational presumptions is an important enterprise for educators to undertake because our understanding of ourselves means so much to our capacity for self-control. Ventimiglia (2008) points out that Peirce himself understood that our understanding of ideal behaviour informs our conduct:

Insightfully, Peirce notes that it is primarily in the choice of our ideals that we exercise control over our conduct. Our actions, our concrete dealings with the world, will follow more or less according to our general account of ideal conduct. In choosing general ends we are influencing the character of the
more specific ends and concrete actions in our future. Our choice of ends is understood by Peirce to be “the only freedom of which man has any reason to be proud”… (Peirce, 1869, p. 72fn., in Ventimiglia, 2008, p. 676)

As Dewey did, it is also my hope to demonstrate the importance of this theory to education. In light of current beliefs and traditions in education, I believe the most significant takeaway is a renewed understanding of the importance of personal agency, and what that might look like in terms of education and education research. Part of this will entail reflecting on each student’s evolutionary ‘legacy’—to comprise, engage, and alter their environments—and will consequently involve being free to explore, uninhibited by norms and expectations that are too rigid to adapt. So important was unfettered inquiry to Peirce that he deigned the first rule of logic to be that “in order to learn you must desire to learn and in so desiring not be satisfied with what you already incline to think,” followed closely by one corollary, which “deserves to be inscribed upon every wall of the city of philosophy,

Do not block the way of inquiry.” (Peirce, 1898, p. 48, emphasis in original)

Recognizing our own unfinishedness, as well as the world’s, allows us a way to continue to see the value in our inquiry, temper our expectations of educational research, and reconsider our own roles as educators. By having an account of the novel, we can learn to not only accept but thrive on possibilities not yet created.
5.2. Implications for the Sciences

The developmental teleology of Peirce naturally begs comparison with the use of developmental psychology in education, and, by proxy, with many student-centered approaches to education that claim to address variety in the classroom. Such educational approaches not only resist novelty, but seem organized to do so, as they seek to delimit and categorize the possibilities for human thinking in an effort to better understand and support development. The argument I have hoped to make is that no theory of development, either on its own or in concert with others, can fully encapsulate the ‘stages’ of human growth, because the stages themselves are always developing. The change, I have tried to argue, is evident at both the level of the individual and the study of the individual.

At the level of the individual, we have seen arguments from Peirce and others that beings individually constitute and shape their environments, and that the entities we perceive and describe are constructs built in collaboration with one another. To Peirce, the mental phenomena garnered through this collaboration are contingent upon beliefs, doubts, and inquiries that are pursued according to aims particular to those individuals. Further, Peirce has argued that the tendencies of development are not only contingent upon prior development, but are also influenced by chance encounters which alter and shape the course of the being to an extent that cannot be entirely predicted in advance. Gardner, in contrast, posited his theory of intelligence as a set of fixed mental mechanisms that apply uniformly and universally to all human beings. Further, he overlooked pursuits at the level of the individual in characterizing those forms of intelligence in favour of greater, societal aims (careers) supposedly evolved into our
innate forms. At the level of study of individuals, Peirce has argued that science must proceed tentatively, ever aware of the ongoing diversification that is taking place. This diverges from Gardner’s approach to study as “a search for general principles” (1983, p. 32), which was founded on his belief that a broader sampling of subjects provided more comprehensive and accurate results that could be applied universally.

If we are persuaded by the more ‘thorough-going’ evolutionary account of Peirce and others, we recognize a challenge to the practice of education research: a theory of development seems incomplete unless it acknowledges the process of growth at every possible level, from individual to cosmos. Gardner’s theory of Multiple Intelligences does not account for growth to this wider extent, and indeed seems positioned against it. In his presentation of the facts, cultural life is external to the development of intelligence, and is presented as stable enough to provide fixed end goals that each intelligence strives toward. Relatedly, Gardner further implies that since intelligences are fixed, science does its best to ascertain them. But there is a risk that such universalized theories of intelligence will become limiting as they deny individual uniqueness, assuming a finite number of possibilities can be comprehensively catalogued and used to facilitate supposedly ‘student-centred’ intervention and control of outcomes. In these cases, research into human and social development may increase in detail, but does not necessarily increase in content as novel, creative evolution demands.

Thus, I argue such educational approaches serve us poorly by enclosing human beings and their minds in static, universal frameworks rather than nurturing novelty or active engagement that may create new forms of thinking and understanding. Such supposedly universal knowledge risks leading to dysfunctional behaviour as we, in our
attempt to meet the needs of diverse learners, risk becoming dogmatic in what those
diverse needs are. Formulating the problem of diversity with norms that are themselves
not up for debate (such as what counts as development, growth, and learning) can cause
the ‘solution’ to defeat the purpose it sets out to resolve, despite our best intentions. For
example, a teacher with too much faith in a scientific profile of learning is likely to think
there is a problem with her student, not her profile, if a student does not act in the way
she expects him to act. This is because theories of learning that present themselves as
universal do not allow teachers the flexibility to adapt to their students’ changing needs.
This example is not hyperbole. Within Differentiated Instruction, for example, although it
is allowed that students may learn to develop new strengths in different intelligences
(Tomlinson, 1999), the approach implies that the categories of intelligence are stable
rather than flexible by drawing on research that states as much. This insinuation, while
seemingly minor, fosters a culture of universal knowledge, because it proclaims
differentiation theory as a product of science (Tomlinson & Kalbfleisch, 1998;
Tomlinson, 1999; Sousa & Tomlinson, 2011). The risk of this approach is that teachers
may strive to guide students along a path of development they are directed to (however
differentiated that path may be), and potentially miss the creative growth (novelty) that
these minds may be in the process of developing. A novel thinker, either through
creativity or an unprecedented chance combination of circumstances, may create a new
form of knowledge or ability that a mechanistic framework of intelligence could not
acknowledge. The risk is especially prevalent as the authoritative word of science is taken
as final truth by Ontario’s own Ministry of Education (as we saw earlier) and mandated
that teachers follow, justified by researchers who claim to have found universal results.
In keeping with Macmillan and Garrison’s (1984) thoughts on the critique of science, it is not my intention to catapult away the entire line of psychological inquiry. However, the above discussion necessitates posing the question to researchers: how can we frame our study, inquiry, and results to align with a continually changing world? As such, I argue that a renewed perspective on the meaning and intention of science ought to take place. Researchers would do well to answer the challenge that no theory of development can fully encapsulate the “stages” of human growth because the stages themselves are developing toward no fixed end. The pragmatists suggest that the goal of inquiry is not to find perfect answers, but to resolve uncertainty in a way that provides a good basis for better directing further inquiry. Following this approach would mean acknowledging that our answers are tentative while we experiment and test for further doubts. As we do so, we are likely to continually shed our “crystallized” notions for new ones that match our changing objectives (Dewey, 1938b, p. 35). As such, science may not provide us universal answers, but practical ones that “[make] possible the systematic pursuit of new ends” (1916, p. 223). Appeals to ideals or universal truths appear less useful than this more tentative approach to inquiry as the subjects of inquiry evolve while they shape and constitute their environments.

5.3. Implications for Educators

According to Peirce’s developmental teleology, it is part of our students’ evolutionary legacy to add to the universe. To act otherwise is to put our students in an impossible situation: using schools to whittle down expectations at the very time the people in them are simultaneously expanding their worlds. This conflicting set of
expectations undermines itself, creating a ‘double bind’ (Bateson, 1979) or paradoxical set of expectations for both students and teachers.

Hoping that I have sufficiently demonstrated the logical inconsistency of more reductivistic educational approaches, I will make recommendations for future approaches to education based on Peirce’s own recommendation, an approach he called *agapasm*, or evolutionary love. Not to be understood as a purely affective stance toward education (Staab, 1999), evolutionary love is an approach to care that attempts to balance chance and mechanical necessity. Rather than seeing development as purely a working of mechanical necessity (an approach Peirce calls *anancasm*), or of complete chance or chaos (which Peirce calls *tychasm*), evolutionary love is a position where one fosters growth as best as she understands it, tempered with an understanding that chance might inspire a new or novel situation she can’t understand. This allows, according to Peirce, for a person to both act according to the way her experience suggests she act, while allowing the next person freedom to explore and achieve their own unique destiny; “The movement of love is circular, at one and the same impulse projecting creations into *independency* and drawing them into *harmony*” (Peirce, 1893, p. 353, emphasis added). It is, to Peirce, “the formula of an evolutionary philosophy, which teaches that growth comes only from love, from—I will not say self- *sacrifice*, but from the ardent impulse to fulfil [sic] another’s highest impulse” (1893, p. 354, emphasis in original).

To act otherwise, according to Peirce, is to succumb to a limited understanding of development. As in the preceding discussion of necessitarianism, to conceive of development as occurring purely through mechanism or necessity is inadequate because “living freedom is practically omitted from its method” (Peirce, 1893, p. 363). On the
other hand, development through pure chance overlooks the importance of continuity in growth: “advance takes place by virtue of a positive sympathy among the created springing from a continuity of mind. This is the idea which tychasticism knows not how to manage” (Peirce, 1893, p. 362). Evolutionary love requires a little of both:

The agapastic development of thought is the adoption of certain mental tendencies, not altogether heedlessly, as in tychasm, nor quite blindly by the mere force of circumstances or of logic, as in anancasm, but by an immediate attraction for the idea itself, whose nature is divined before the mind possesses it, by the power of sympathy, that is, by virtue of the continuity of mind. (Peirce, 1893, p. 364)

This approach extends current work on the value of care in the classroom (Noddings, 1984, 2002) by promoting an understanding of human ‘minding’ that allows for the dynamicism that propels the evolving creature. It thus would change teachers’ roles from one of mere stewardship, as Gardner’s theory proposes (carrying students from one stage of understanding to the next in predetermined paths), to one of celebration (fostering student growth but with a mind to appreciate the new forms of knowledge they may encounter in their classrooms). Thus, I argue that in addition to calling for a renewed philosophy of inquiry, Peirce’s account of evolutionary love calls for a renewed philosophy of education, a pedagogy that accounts for change.

This renewed perspective is possible in education—a revised account of the meaning and intention of education can be incorporated in our pedagogical expectations.
For teachers, this includes revising how we approach learners, transforming our role from being mere facilitators of learning and manufacturers of learning environments to those who celebrate the more dynamic and unique side of development. Just as Peirce showed that we tend to notice regularities more than irregularities and dismiss chance occurrences as unimportant, so educators can also be mindful that having student profiles, such as the MI scheme that Differentiated Instruction utilizes, can make us blind or neglectful of the ways children demonstrate their creative intelligence when that isn’t included in those schemes. When students are considered as having unique forms of intelligence, it means that the seeds of new, future systems of thought are present with them; they are the source of the variety that will keep social life enduring under new conditions, just as how biological life is more likely to survive when its population has greater internal diversity (Bateson, 1979). This changes our question from only considering what we have or know to teach our children, to how we can be open to what might be coming next in the space created by our interactions. Teachers can act in a way that fosters growth in new directions, by asking themselves, “Does this form of growth create conditions for further growth, or does it set up conditions that shut off the person who has grown in this particular direction from the occasions, stimuli, and opportunities for continuing growth in new directions?” (Dewey, 1938a, p. 36). In doing so, it asks teachers to maintain a will to learn (Peirce, 1898, p. 48).

Doing so doesn’t just affect our students, it affects us as teachers, too, as we are reciprocally constituted and constituting each other. The freedoms we allow each other are, in the end, the freedoms we allow ourselves. As Peirce states,
Nor must any [one] say, “I am altogether myself, and not at all you.” If you embrace [evolutionary love], you must abjure this metaphysics of wickedness. In the first place, your neighbors are, in a measure, yourself, and in far greater measure than, without deep studies in psychology, you would believe. Really, the selfhood you like to attribute to yourself is, for the most part, the vulgarest delusion of vanity. In the second place, all men who resemble you and are in analogous circumstances are, in a measure, yourself, though not quite in the same way in which your neighbors are you. (CP 7.571)

Thus, the evolutionary freedom we allow our children are not rights or benefits exclusive to early life, but are part of the rights and freedoms we extend to all living beings. Teachers, similarly, are owed the freedom and flexibility of creative engagement with their work and materials, as the creative process of social growth depends on their engagement, too. This does not necessarily mean disposing of all lesson and assessment materials, but does call for an examination of the freedom and agency teachers have in selecting, evaluating, and proposing changes to formal learning guides.

Using a Peircean, evolutionary approach, I have attempted to analyze and critique a common educational approach in light of a conceptual understanding of evolutionary change. In doing so, it should be seen that I engage a much different enterprise than others have done in using scientific facts of evolution to make definitive claims about our heritage of learning (see Grey, 2013; Buss, 2015; but Buller, 2005b). Rather, I have intended to map existing research onto philosophical principles of chance and variation,
in an attempt to articulate an understanding of individuals who change and grow in environments that also change and grow. It is my hope that this discussion of the epistemological and ontological implications of chance will illuminate often-overlooked aspects of self and individual development, but also have farther-reaching implications in terms of the role of society and environment in learning. This is an important alternative to the dominant educational approach of universalizing generalizations made in cognitive science and psychological research to education. Gardner’s position resembles that which Peirce described as only partially evolutionary: it holds that certain aspects of evolution are important, but “admit[s] other primordial elements…to be necessary factors” (Peirce, 1883-84, p. 222). Although Gardner holds that evolution played a role in the development of thought, he overlooks the process of transaction, and thus chance, in this process. This could be remedied by taking on a more “thorough-going evolutionism” (Peirce, 1891, p. 289). Adopting an approach informed by a theory of evolution, we will hesitate to claim that there are seven different intelligences (Gardner, 1983), or eight (Gardner, 1995a), or nine (Gardner, 1999) or ten (Gardner, 2016), or even a million for that matter, as we consider that it is plausible there are as many different intelligences as there are people. If we adopt Peirce’s developmental teleology, we accept that we are each engaging and testing our experiences in literally unique ways, as no two creatures appear to engage the same environment with the same tools at their disposal. If this discussion is successful, cognitive tools and ‘intelligences’ will not be seen as merely genetic or otherwise inherited fittings as Gardner suggests, but an arsenal of habits and tools, acquired, tested, and changing according to unique and developing goals.
This discussion aims to be timely, as proponents of Differentiated Instruction (and other student-centered approaches to teaching) are maintaining the reductivist, nativist, and mechanistic model of mind and intelligence. They are, further, teaming up with neuroscientists to reveal the so-called ‘hard facts’ of diversity to bolster their mass appeal and support from governing bodies. The current educational trend of brain-based education, meant to support variety in students, has supposed that the better we can understand our ‘wetware’, the better we can program some software. Yet findings from other evolutionary studies suggest we are more than the sum of our parts—we are evolving creatures who grow with our environments and who are touched by chance. The field of education would do well to listen.
REFERENCES


Immordino-Yang (Eds.), *Mind, brain, and education in reading disorders* (pp. 16-29). Cambridge, UK; New York: Cambridge University Press.


