Evolving Educational Pedagogy in Developing Nations

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Abstract

The developing countries of the world face many major social challenges, among these challenges is education. It seems that the tendency would be to merely transport current educational pedagogy to these developing nations. But the existing pedagogy primarily fosters the development of ruled-based thinking, which will not suffice given the demands of the current day. Thus a new model for education is in order; one that will address the need: for life-long learning, for learning-how-to-learn, for being able to apply knowledge to unfamiliar circumstances. Developing nations, as many nations of the world do, need new educational pedagogies to foster change to meet new challenges. However developing nations need more than this, they need build, not just rebuild the infrastructure. This creates a situation where bold ideas need to be spawned as old ideas, in many cases, do not exist. Thus in developing nations there is a unique opportunity to: *a*. build an infrastructure from the ground up, and, *b*. deploy a novel educational pedagogy without having to confront a well established, well entrenched, infrastructure. This paper offers a novel metamodel for education, which goes beyond the development of rule-based thinkers, to evolve model-based reasoning skills an a model for focusing the intent of education itself. Taken together these two aspects of our novel model for education will provide a new basis for education and for the development of deep reasoning skills within various curricular areas, which will provide the needed tools for those who will confront the coming global village and live in the global community.

1. Introduction

> The education establishment, including most of its research community, remains committed to the educational philosophy of the late nineteenth and early twentieth centuries, and so far none of those who challenge these hallowed traditions has been able to loosen the hold the educational establishment has on how children are taught.
>
> - Seymour Papert, *The Children's Machine*

Recent technological advances have created a digital divide that has touched the lives of a certain segment of the world's population but has yet to touch the lives of the vast majority of people on this planet. For example, schools in the 'wired world' have vast resources at their fingertips; schools not in the 'wired world' have little in the way of modern-day educational tools. But much to their credit, the 'have-not' schools are open and receptive to assistance from those who 'have' and are willing to share.

In 1950 US Army General Douglas MacArthur brought Dr. Edwards Deming to Japan to (re)build their infrastructure by introducing the theory of quality assurance and quality control.

MacArthur wanted to not only rebuild the Japanese infrastructure; but he wanted to insure that the foundational concepts, which would be embodied in the new Japan, would be a model for the world. MacArthur did just that. The Japanese mastered this concept as it had never been mastered before—and they did this much to the astonishment of the USA. 'Made in Japan' went from a codeword for junk to a badge of excellence in a short time. Today a similar opportunity exists to not only (re)build the educational infrastructure of developing nations but to make their educational system a model for the world.

Current learning theory in the USA and in the developed countries of the world "does not provide a simple recipe for designing effective learning environments" [Branford, 1999]. "New developments in the science of learning raise important questions about the designs of learning environments…[the] general characteristics of learning environments…[and provide a] need to be examined in light of new developments in the science of learning" [Bransford, 1999]. The basis of a model that will serve as a foundation for educational pedagogy should be embodied from such a mind-set (developing model-based thinkers). Educators should recognize the affective and cognitive state of the learner and respond in an appropriate manner (e.g., adjust the pace, direction, complexity) is critical. When designing educational systems from *square one* one should:

1. Develop model-based reasoners, and

2. Be sensitive to the affective state of the learner and adjust the learning journey accordingly.

This will foster the educational maturation of adult citizens who will be able to learn-how-to-learn and perform model-based reasoning, which is a critical skill for the present day global economy/village.

2. Re-targeting and Re-focusing Educational Pedagogy

Current educational philosophy (Figure 1), which pervades the developed world, tends to focus on the means to provide 'information' to the masses. This leads to standardized tests that draw out this 'information' and those who can extract it are judged to be 'educated' or worse 'intelligent'—but this is not intelligence. This approach/belief merely develops a generation of people who will make great *game-show-contestants*. It does little to provide future adult citizens with needed capacities. It does develop rule-based learners in an era that yearns for model-based reasoners.

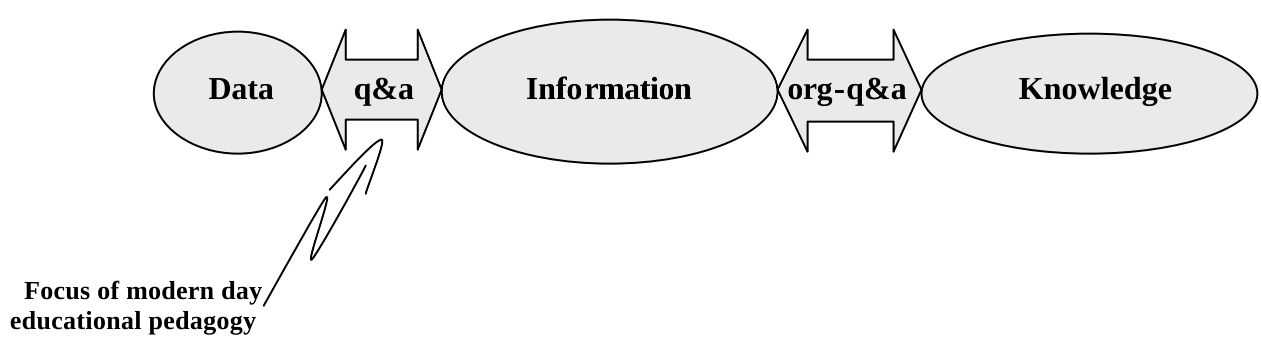

Figure 1 -- Model to Support Rule-based Thinking

To understand the need for a novel model (see Figure 2) it is necessary to explore the current model. The current model, as shown in Figure 1, begin with 'data.' 'Data' (in Figures 1 and in Figure 2) is an accumulation of answers to as yet unasked questions; 'information' is the answer to an asked question. 'Information' is like the pieces to an unassembled jigsaw puzzle and 'knowledge' is the assembled jigsaw puzzle.

In the normal education flow of the present day, a student is given 'data' (the answer to an unasked question). Then the 'data' becomes 'information' when a question is asked. To move from 'Data' to 'Information,' one must find Question-Answer Pairs that link each 'Anecdote' or 'Data' (in Figure 2) to a corresponding Question. And again,' Information' is like the pieces of an unassembled Jigsaw Puzzle. 'Knowledge' is like an assembled jigsaw puzzle. The Question-Answer pairs are organized into a structure, in the logical order in which new questions arise. The structuring methodology is largely due to Socrates (the Socratic method).

'Knowledge' (in Figures 1 and 2) is analogous to an assembled jigsaw puzzle; and it reveals a previously hidden Big Picture. Seeing this Big Picture is called Insight (moving ahead a bit to Figure 2). The Jigsaw Puzzle of Knowledge is like a Tapestry into which is woven many otherwise hidden and previously unrevealed stories.

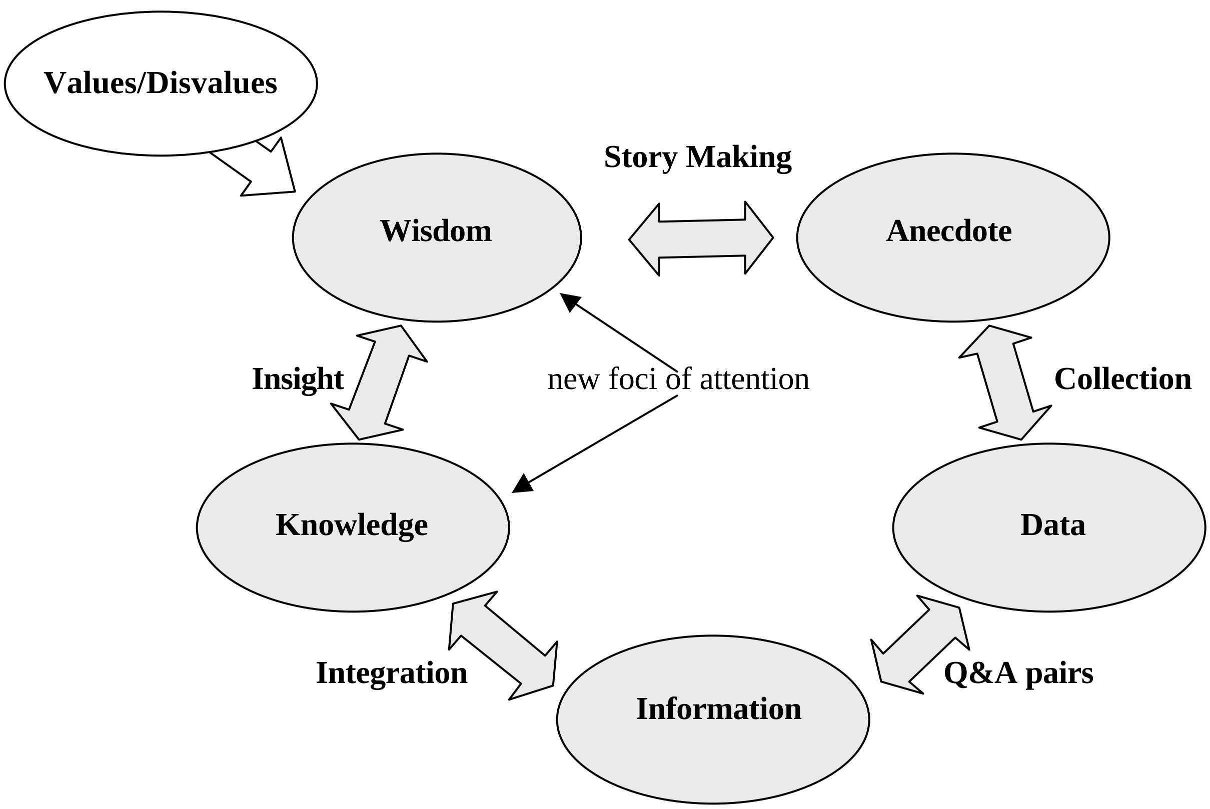

Figure 2 -- Novel Model of Educational Pedagogy

But the novel model (Figure 2) that is offered here goes beyond the current day model shown in Figure 1. The foci of attention is drawn away from a focus on providing 'data' and developing the ‘data’ into ‘information’ to focusing on the development of ‘knowledge’ (through some sort of ‘insight’) and the development of ‘wisdom’ in the presence of a Values System (or this may be characterized as the application of ‘knowledge’).

To further clarify the model in Figure 2, ‘Insight’ which fosters ‘wisdom’ from ‘knowledge’ is the act of seeing the picture as revealed by the assembled ‘jigsaw puzzle of knowledge.’ To move from ‘knowledge’ to ‘wisdom’ one must fold in a Values Systems (one’s moral compass), which ties into purposes and desires.

‘Wisdom’ is the ability to see and extract the stories woven into the Tapestry of Knowledge. So from ‘Wisdom’ we get the Art of Story Making. The ancients crafted Myths, which were the prototypical stories of their cultures. A Story is an anecdotal model drawn from the culture—this starts the cycle.

This provides a novel model that will, on a meta level, provide foundational educational pedagogy. On an operational level the models offered here will provide a basis for formulating appropriate intervention strategies. This will serve as a linchpin for the next part of our model—how a learner’s affective state should be incorporated into the meta model, which is an overall approach to education

3. Affective State: Emotions and Learning

> The extent to which emotional upsets can interfere with mental life is no news to teachers. Students who are anxious, angry, or depressed don’t learn; people who are caught in these states do not take in information efficiently or deal with it well.
>
> - Daniel Goleman, *Emotional Intelligence*

In an attempt to install/build/reengineer the current state of educational pedagogy, the new breed of educators should first look to expert teachers who are very adept at recognizing the emotional state of learners and based upon their observation, take some action that positively scaffolds learning. But what do these expert teachers *see* and how do they decide upon a course of action? How do students who have strayed from *learning* return to a productive path, such as the one that Csikszentmihalyi [1990] refers to as the “zone of flow”? This notion that a student’s affective (emotional) state acts learning and that appropriately intervening based upon that affective will facilitate learning is not new concept, but it has not been well researched.

To prove our point note that skilled humans can assess emotional signals with varying degrees of precision, and researchers are beginning to make progress giving computers similar abilities at recognizing affective expressions [e.g., Picard, 2000; Scheirer, et. al., 1999] and facial expressions [e.g., Donato, 1999; DeSilva, 1997; Ekman, 1997]. Although computers only perform as well as people in highly restricted domains, we believe that accurately identifying a learner’s emotional/cognitive state is a critical indicator that will determine how to assist the learner in achieving an understanding of the efficiency and pleasure of the learning process. We also assume that computers will, much sooner than later, be more capable of recognizing human behaviors that lead to strong inferences about affective state.

To this end it is necessary for us to rethink our perspective of what is happening during learning and based upon our hypothesis, reengineer accordingly. This supposition is based upon our own preliminary pilot studies, with elementary school children suggest that a human observer can assess the affective emotional state of a student with reasonable reliability based on observation of facial expressions, gross body language, and the content and tone of speech. If the human observer is also acting in the role of coach or mentor, these assessments can be confirmed or refined by direct conversation (e.g. simply asking the student if they are confused or frustrated, before offering to provide coaching or hints). Moreover, successful learning (e.g. solving a difficult puzzle) is frequently marked by an unmistakable elation, often jointly celebrated with "high fives." In some cases, the "Aha!" moment is so dramatic, it verges on the epiphanetic. One of the great joys for an educator is to bring a student to such a moment of triumph.

Our first step is to offer a model of a learning cycle (Figures 3a and 3b) and later to describe this model of emotions (Figure 4). Figures 3a and 3b attempt to interweave the emotion axes shown in Figure 4 with the cognitive dynamics of the learning process. The horizontal axis in figures 3a and 3b is an Emotion Axis. It could be one of the specific axes from Figure 4, or it could symbolize the *n*-vector of all relevant emotion axes (thus allowing multi-dimensional combinations of emotions). The positive valence (more pleasurable) emotions are on the right; the negative valence (more unpleasant) emotions are on the left. The vertical axis is what we call the Learning Axis, and symbolizes the construction of knowledge upward, and the discarding of misconceptions downward. (Note: we do not see learning as being simply a process of constructing/deconstructing or adding/subtracting information; this terminology is merely a projection of one aspect of how people can think about learning. Other aspects could be similarly included along the Learning Axis.)

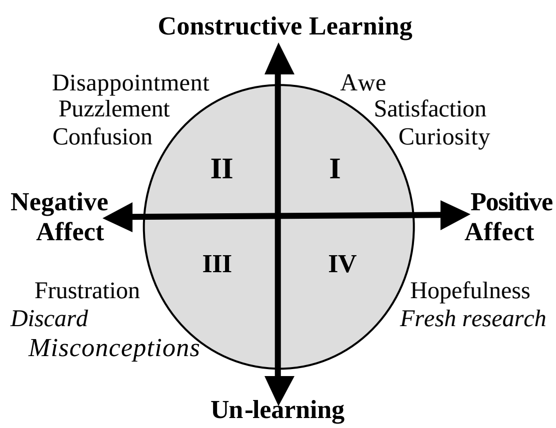

Figure 3a – Proposed model relating phases of learning to emotions in Figure 2

The student ideally begins in Quadrant I or II: they might be curious and fascinated about a new topic of interest (Quadrant I) or they might be puzzled and motivated to reduce confusion (Quadrant II). In either case, they are in the top half of the space, if their focus is on constructing or testing knowledge. Movement happens in this space as learning proceeds. For example, when solving a puzzle in *The Incredible Machine*, a student gets an idea how to implement a solution and then builds its simulation. When she runs the simulation and it fails, she sees that her idea has some part that doesn't work – that needs to be reconstructed. At this point it is not uncommon for the student to move down into the lower half of the diagram (Quadrant III) where emotions may be negative and the cognitive focus changes to eliminating some misconception. As she consolidates her knowledge—what works and what does not—with awareness of a sense of making progress, she may move to Quadrant IV. Getting a fresh idea propels the student back into the upper half of the space, most likely Quadrant I. Thus, a typical learning experience involves a range of emotions, moving the student around the space as they learn.

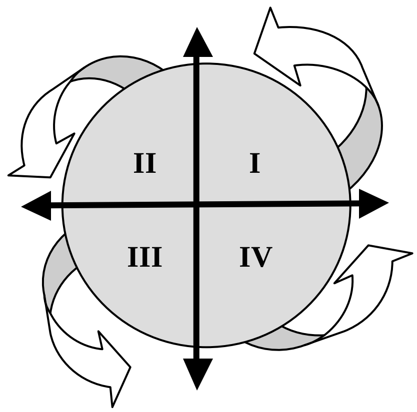

Figure 3b – Circular and helical flow of emotion

Axis	-1. 0	-0. 5	0		+0. 5	+1. 0
Anxiety-Confidence	Anxiety	Worry	Discomfort	Comfort	Hopeful	Confident
Boredom-Fascination	Ennui	Boredom	Indifference	Interest	Curiosity	Intrigue
Frustration-Euphoria	Frustration	Puzzlement	Confusion	Insight	Enlightenment	Epiphany
Dispirited-Encouraged	Dispirited	Disappointed	Dissatisfied	Satisfied	Thrilled	Enthusiastic
Terror -Enchantment	Terror	Dread	Apprehension	Calm	Anticipatory	Excited
Humiliated-Pride	Humiliated	Embarrassed	Self-conscious	Pleased	Satisfied	Proud

Figure 4 – Emotion sets possibly relevant to learning

If one visualizes a version of Figures 3a and 3b for each axis in Figure 4, then at any given instant, the student might be in multiple Quadrants with respect to different axes. They might be in Quadrant II with respect to feeling frustrated; and simultaneously in Quadrant I with respect to interest level. It is important to recognize that a range of emotions occurs naturally in a real learning process, and it is not simply the case that the positive emotions are the good ones. We do not foresee trying to keep the student in Quadrant I, but rather to help him see that the cyclic nature is natural in learning science, mathematics, engineering or technology (SMET), and that when he lands in the negative half, it is only part of the cycle. Our aim is to help them to keep orbiting the loop, teaching them how to propel themselves especially after a setback.

A third axis (not shown) can be visualized as extending out of the plane of the page—the Knowledge Axis. If one visualizes the above dynamics of moving from Quadrant I to II to III to

IV as an orbit, then when this third dimension is added, one obtains an excelsior spiral when evolving/developing knowledge. In the phase plane plot, time is parametric as the orbit is traversed in a counterclockwise direction. In Quadrant I, anticipation and expectation are high, as the learner builds ideas and concepts and tries them out. Emotional mood decays over time either from boredom or from disappointment. In Quadrant II, the rate of construction of working knowledge diminishes, and negative emotions emerge as progress flags. In Quadrant III, the learner discards misconceptions and ideas that didn't pan out, as the negative affect runs its course. In Quadrant IV, the learner recovers hopefulness and positive attitude as the knowledge set is now cleared of unworkable and unproductive concepts, and the cycle begins anew. In building a complete and correct mental model associated with a learning opportunity, the learner may experience multiple cycles around the phase plane until completion of the learning exercise. Each orbit represents the time evolution of the learning cycle. Note that the orbit doesn't close on itself, but gradually moves up the knowledge axis.

We need to explore the underpinnings of various educational theories and evolve or revise them. For example, we propose a model that describes the range of various emotional states during learning (see Figure 4). We are in the process of performing empirical research on this model to gather data to justify our hypothesis. We have conducted several pilot research projects, which appear to support our hypothesis, and will be continuing to conduct research in this area.

The model is inspired by theory often used to describe complex interactions in engineering systems, and as such is not intended to explain how learning works, but rather is intended to give us a framework for thinking about and posing questions about the role of emotions in learning. Like with any metaphor, the model has limits to its application. In this case, the model is not intended to fully describe all aspects of the complex interaction between emotions and learning, but rather only to serve as a beginning for describing some of the key phenomena that we think are all too often overlooked in learning pedagogy. This model goes beyond previous research studies not just in the emotions addressed, but also in an attempt to formalize an analytical model that describes the dynamics of emotional states during model-based learning experiences, and to do so in a language that the SMET learner can come to understand and utilize.

4. And in Conclusion

> Why is there no word in English for the art of learning? Webster says that *pedagogy* means the art of teaching. What is missing is the parallel word for learning. In schools of education, courses on the art of teaching are simply listed as “methods.” Everyone understands that the methods of importance in education are those of teaching—these courses supply what is thought to be needed to become a skilled teacher. But what about methods of learning?
>
> - Seymour Papert, *The Children’s Machine*

We stand at the gates of an opportunity that seldom presents itself. This opportunity is to do great things for large numbers of people. Specifically we can not only reinvent education, but for the developing nations we can invent it, we can facilitate it effective implementation into schools, we can impact the children who will soon be the adults of the 21st century by providing them an education that will prepare them to 'learn how to learn,' which is an essential skill and will enable these adults to compete in the world economy.

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