12-10-2017

Natural Law as Integrative Framework for Data Analytics Education

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Pedagogical Study

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Abstract

Teaching the multidisciplinary field of Data Analytics requires comfort with multiple domains of knowledge, each with its own assumptions, concepts and skills. Ideally, such teaching will use an overarching framework that transcends and subsumes all the reference fields. Natural law provides such an unchanging framework and a stress-free and sustainable path to continued learning. Teaching from Natural Law helps enhance the student's capacity for comprehension and integration of diverse knowledge and skills. This paper presents seven key Natural Law principles, along with examples of their applications in teaching data analytics.

Keywords

Data Analytics, Teaching, Natural Law, Principles, Knowledge, Consciousness, Holistic.

Introduction

Data Scientist has been called the 'sexiest' job of the decade (Davenport & Patil, 2012). As a result, there is a great demand for Data Analytics education, and for educators and pedagogical resources to serve that demand. The pedagogical techniques should enable the integration of knowledge and skills from multiple reference fields such as business management, sociology, mathematics, statistics, and computer science, which all contribute to Data Analytics.

McBride and Hackney (2003) call out the need for developing integrative principles for teaching Information Systems (IS), as it is a multidisciplinary field. They ask teachers to help students think in a structured manner. Pedersen, Nygaard and Pedersen (2010) also recognize the integration challenge and call for a necessary transition from input-based to output-based curricula in IS and help develop the right competencies among students. Carugati et al (2014) similarly recognize that teaching IS to executives can be a very challenging task because of their previous experiences, variation in their previous education, and multiplicity of motivations for pursuing a continuous education.

McBride and Hackney (2003) offer integrative IS teaching principles such as:

- *Establish a series of generic frameworks or patterns in your teaching that can be applied to changing technologies and business practices. Derive these bottom-up from observing practice and top-down, drawing on theories across disciplines.*
- *Educate your students in critical thinking. Always apply critical thinking to the selection of topics and sources.*
- *Always seek to provide a learning environment where the student comes to her own understanding of IS, and generates her ownership of principles and practices for herself.*

We completely agree that generic frameworks must transcend and support changing technologies and reference disciplines to be able to answer this challenge. Such generic frameworks should be strong and broad enough to accommodate Data Analytics and other disciplines that the future Data Analyst is expected to learn, to stay effective in her work. The integrative framework should be more powerful than the

exponentially growing Data Analytics field. We also agree that critical thinking is a useful way to free oneself from any particular beliefs and practices from reference disciplines, that may prove limiting for interdisciplinary work. We also agree that students should become active learners and take full ownership of their own principles and practices. Providing a generative learning environment will involve developing the creative capacity of the students.

Llewellyn & Pearson (2011), based on the teachings of Maharishi Mahesh Yogi (1963, 1995), present an emerging "Development of Consciousness" paradigm of education. It places primary emphasis on the knower, i.e. on developing the knower's potential for learning from within (Figure 1). In comparison, the Learning paradigm focuses on improving the student's process of knowing/learning, while the Instruction paradigm focuses on efficiently communicating the known/knowledge to the students.

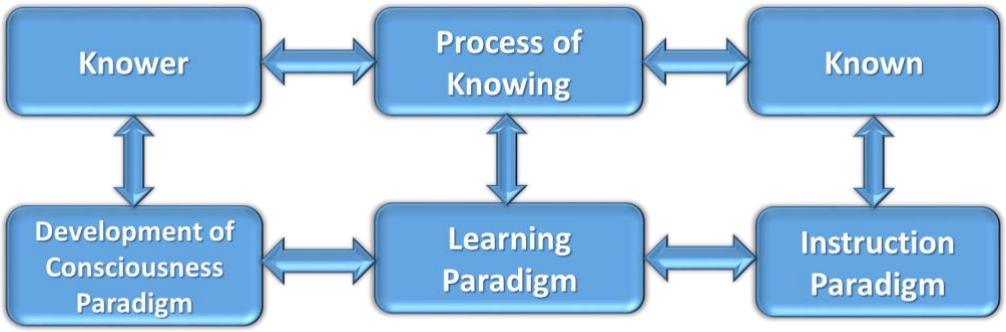

Figure 1: Paradigms of Education (Adapted from Llewellyn & Pearson, 2011)

Development-of-Consciousness paradigm proposes that all knowledge is integrated in the consciousness of the student/learner/knower. Consciousness is the field of infinite correlations, where everything is connected to everything else (Nader, 2015). As a correlate, quantum physics has demonstrated that quantum systems possess additional correlations that do not have a classical counterpart (Osterloh et al. 2002). Similarly, the quality of perception and knowledge is different at different states of Consciousness.

Regular practice of Transcendental Meditation (TM) and/or similar techniques can help develop greater self-awareness. Regular practice of TM technique by college students has been shown to lead to higher brain integration score, lower stress, and higher creativity (Travis, et al., 2009; Travis 1979). Once the student develops higher creative capacity, she can naturally grow her knowledge organically and holistically, with less effort and a great sense of accomplishment and fulfilment. The way to enhance integrative learning is thus to enliven the student's consciousness.

Natural Law as Integrative Framework

Consciousness is the unified field of all the laws of nature (Hagelin, 1987). These universal laws/principles have been cognized by thinkers and seers and have stood the test of time. They are reflected across human experience, from ancient Vedic texts to quantum physics theories (Maharishi Mahesh Yogi, 1963). These principles can not only help integrate the reference disciplines, but can help bring happiness and fulfilment to the data analyst, the client, and all other stakeholders. When these principles are allowed to work as nature designed, learning is catapulted to new heights, just as astronauts use their knowledge of gravitation to slingshot around planets. Everyone should be trained in the knowledge and application of Natural Law to enjoy effortless success and fulfilment in life (Maharishi, 1995).

Natural laws include scientific principles – for example, energy is always conserved. It also includes other principles such as – the nature of life is to grow. This paper will present the following seven such Natural Law principles (NLPs), with their applications and implications for teaching Data Analytics.

1. *Knowledge is structured in consciousness*. Knowledge is different in different mental states. What one sees depends upon what one experiences in one's own mind. Thus one should aim to purify one's consciousness, sharpen perception, and expand awareness.

2. *Truth is One, it is expressed in many ways*. The same sap is expressed in different ways in the root, the trunk, the leaves, the flowers, and the fruit of the tree. One should be deeply open to multiple manifestations and interpretations of reality to get to the total Truth.
3. *Nature is found in layers*. As one's consciousness evolves, one becomes aware of many layers of reality. One should seek the highest first. One should know that by knowing which everything else is known.
4. *The Nature of Life is to grow*. That which one pays attention to, grows in one's consciousness. Awareness of the flow of one's attention helps accentuate the positive.
5. *Water the root and enjoy the fruit*. One should identify the root cause of the problem, and then try to solve it.
6. *Dive in at the right angle for effortless success*. Choosing the correct approach to action can make it effortless and enhance the chances of success. One can do less and accomplish more.
7. *Established in Self, perform action*. By acting from a state of wholeness and equanimity, one is assured of the most appropriate path to success.

Principle 1: Knowledge is structured in Consciousness

This is arguably the highest principle of Natural Law. What one sees and hears depends upon one's state of consciousness. When stressed, one is unlikely to experience the totality of the situation. Similarly, in a state of stress there is a reduced likelihood of generating creative solutions and frameworks. On the other hand, when one is relaxed and self-aware, one will likely recognize and realize many things at different levels.

Application 1: Teach Wholeness First

It is important to encapsulate the knowledge of the interdisciplinary field of Data Analytics in a few words and a picture, to charm and engage the students. Here is an example of holistic description of the field of Data Analytics (Maheshwari, 2014):

Business is the act of doing something productive to serve someone's needs, and thus earn a living and make the world a better place. Business activities are recorded, and these records become data. There is more data from industry and economy as a whole. All this data can be analyzed and mined using special tools and techniques to generate patterns and intelligence, which reflect how the business is functioning. These ideas can then be fed back into the business where courageous executives can use the insights to help the business evolve to better serve customer needs. The business grows and more data is gathered, and so the cycle continues (Figure 2).

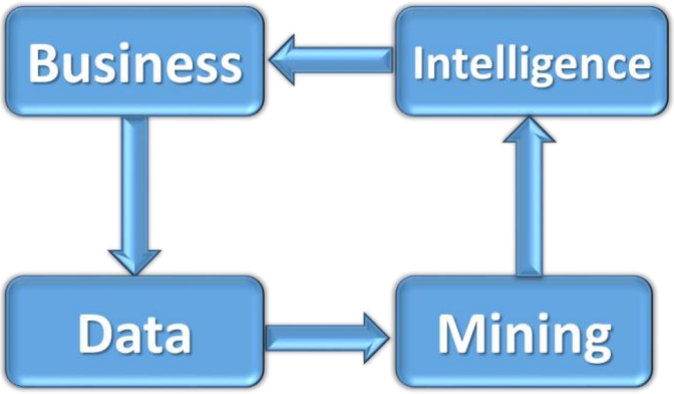

Figure 2: Business Intelligence and Data Mining Cycle

Application 2: Holistic pedagogical materials

Data Analytics education can become enjoyable when using effective textbooks and teaching materials. For a student, learning becomes joyful when she finds it easy to grasp the central truth. Even when the topic is technical, the teaching materials should isolate the complexities to ensure a smooth flow of narrative and provide joy to the reader.

The first page of a book can introduce the field in its totality.

The first chapter of the book can unfold that first page in greater detail.

The first section of the book can expand on the first chapter.

The rest of the book can expand on that first section.

The reader thus dives into the field progressively, enjoying greater detail without losing a sense of connection with the wholeness. Every chapter should begin with its own wholeness, which should then be expanded in the body of the chapter.

The first chapter of the book can explain the progression of data analytic activities (Figure 3). Other chapters can cover these sub-fields. The use of a simple single running example can demonstrate the transformation of data at each stage, thus brings all constructs in sharp relief.

Figure 3: Data Analytics Process Chain

Principle 2. Truth is One, it is expressed in many ways.

This is closely related to the first principle above. External reality is in constant flux and transformation. Even the perceptive powers of the knower also change. At one level, the world exists independently of what one thinks or knows. At another level, reality is what is in one's awareness. Experts from individual domains of knowledge tend to have diverse preconceived expectations or perspectives, which are all partially true. The underlying total reality however is the unified field of all the laws of nature. The teacher and student can act from a settled state of mind and be able to experience deep interconnections and knowledge in data.

Application 3: Multidisciplinary teams

An interesting way to teach a multidisciplinary subject is to gather students from multiple disciplines, such as Business Management, Mathematics, and Computer Science, into one class. The primary benefit would be to facilitate cross-learning. Project teams created with members from all participating disciplines bring together a rich set of competencies. Business management students naturally bring better domain knowledge, communication skills, and project management. Computer science students naturally bring a deeper understanding of algorithms, and ability to gather and organize the data, and use data analytic platforms. Mathematics students can help with modeling the data. And so on. Some members of the group naturally gravitate towards problem identification, and others towards finding solutions. Some are quick in analyzing the data, while others are adept at interpreting and communicating the results. After a bit of familiarization, the students begin to understand each other's jargon and communication styles, and enjoy the rich, interactive learning environment. It can help them own the data analytics knowledge in a more holistic manner.

Application 4: Multidisciplinary Projects

Related to the above application is the idea of using research questions that span multiple domains of knowledge. Finding the right research question is of great importance in Data Analytics. An important research project would be one whose successful execution will bring a high payoff. A project will be more challenging and interesting, if the variables could come from different disciplines and perspectives. For example, an interesting data analytics project would be to examine the relationship between education level and the divorce rates in a society. Such a project would be interesting if the answers are exploratory and not confirmatory, i.e. either there are no existing answers, or the answers could be theoretically justifiable either way. Such projects are more interesting if, a priori, some members of the project team believed that these variables will be positively correlated, and the other members believed that the variables will be negatively correlated. When the project group members, with their different backgrounds, have divergent

understanding and expectations of causal behavior among the variables, data analytics aids the learning by potentially providing a definitive answer. It also enhances appreciation for the power and value of data analytics.

Principle 3: Nature is found in layers

This principle of layered reality is also related to the earlier principles. Phenomena can be observed at the ordinary level, and they can also be perceived at subtler levels. In fact, there is greater power in the subtler levels of knowledge, just like there is greater power going from molecular to nuclear scale. One should start with teaching the highest and integrated value of the Data Analytics first, and then add details in additional layers.

Application 5: Main Points and UNITY Chart

A key practice in consciousness-based education is to relate every topic to overall knowledge using a "Main Points and Unity chart". The Main Points in the chart express the highest level of observable knowledge of that topic in the form of key messages. The Unity part of the chart connects that knowledge to the subtler levels of the Self. It helps the student integrate the new knowledge in her own consciousness. Connecting every topic and course with the Self helps create an integrated understanding of all knowledge. This may in turn help with greater retention of knowledge. These charts could be used at the end of a class session to summarize the learnings. A sample Main Points and Unity chart is shown in the Appendix.

Application 6: Bridging the domains of knowledge

Understanding Big Data is a challenge for most individuals and organizations. At one level of thinking, Big Data is just any other large dataset. At another level, however, Big Data needs special attention. It is a deeper, bigger, faster, unstructured layer of data, which has special characteristics of the 4Vs (Volume, Velocity, Variety, and Veracity). The V-structure of Big Data can be superimposed on Figure 2 to create a multi-layered model of Data Analytics (Figure 4).

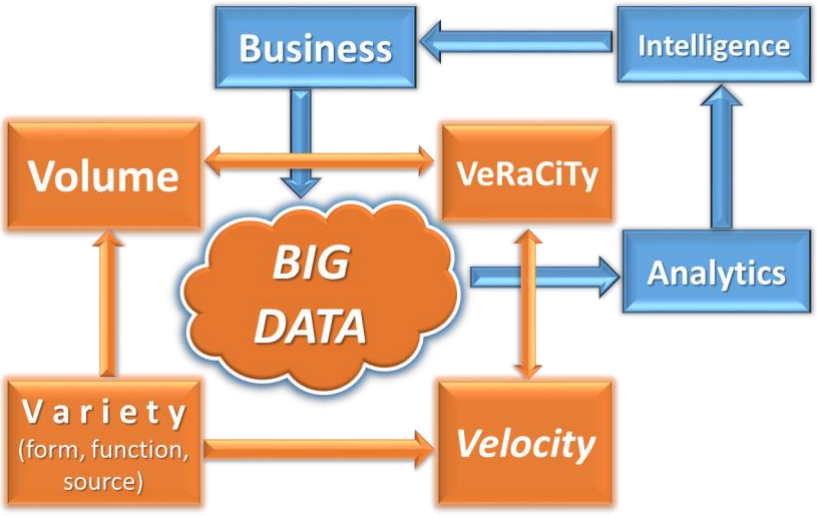

Figure 4: Multi-layered view of Big Data Analytics (Source: Maheshwari, 2016)

The four Vs can be explained in relation to each other, and to the technologies for Big Data.

Variety of data, such as social media data, leads to explosion in volume of data.

Variety of data, such as machine data, creates a torrent of data, thus creating velocity.

Velocity (urgency) leads to transmitting partially completed results, and creates Veracity issues

Veracity (partially complete data) requires multiple transmissions and adds to volume of data.

Similarly, the 4 Vs can be related to Big Data technologies that address the challenges (Table 1).

Challenge	Description	Solution	Technology
Volume	Avoid risk of data loss from machine failure in clusters of commodity machines	Replicate segments of data in multiple machines; master node keeps track of segment locations	Hadoop Distributed File System
Volume & Velocity	Avoid choking of network bandwidth from having to move large volumes of data	Move processing logic to where the data is stored; manage using parallel processing algorithms	MapReduce
Variety	Efficient storage of large and small data objects	Columnar databases using key-pair values format	HBase, Cassandra
Velocity	Monitoring streams too large to store	Fork-shaped architecture to process data both as stream and as batch	Apache Spark, kafka

Table 1: Mapping Big Data characteristic to Technological Solutions

Principle 4. The Nature of Life is to grow.

Everyone naturally wants to grow and realize their full potential. The seed has the potential to grow into a huge tree. Students want to grow in knowledge and ability to take on complex projects and achieve big goals. Teachers want to grow in their knowledge and effectiveness, to teach more advanced subjects to more advanced students. Students should be exposed to progressively complex topics to develop confidence in their ability. Teachers can grow by investing time and effort in developing pedagogical tools such as textbooks, workbooks, datasets, and cases, for oneself and for others.

Application 7: Self-published pedagogical tools

Self-publishing online has become easier than ever before. A self-published book, for example, can be organized around one's holistic view of data analytics field, and expressed in one's own preferred communication style. The book's content could be targeted at the levels of students that one normally teaches. Only the set of topics that one is interested in teaching should be included in the textbook. Some primers for reference topics, and programming tutorials, can be appended to the book to make it self-sufficient for a variety of students. The size and cost of the book for the student can thus be kept reasonable. The process of creation also brings joy and fulfilment to the educator.

Application 8: Self-referral Data Sets

Self-referral data sets can be another attractive pedagogical tool. One can derive self-understanding from analyzing data about one's own self. Students are more engaged when learning from their own data. For example, one could gather a few simple demographic and other characteristics of the students in class. These variables include age, gender, height, weight, country of origin, and more. Over time this data set can grow to hundreds of data points. The dataset can be used for many different analytics techniques. One can construct a predictive model using a decision tree. Using cluster analysis, it is possible to cluster the data into distinct student sets. These datasets could also be shared with the larger data analytics community.

Principle 5. Water the root and enjoy the fruit.

This principle relates closely to the principles 3 & 4 above about layers and growth. Attention must be paid at the right level for future success. For example, tending to the leaves will not improve the health of a tree. Similarly, focusing the improvement efforts on the surface-level indicators will not increase the quality of

teaching and learning. Students need to develop the skills and confidence to identify the root of the problem and address it the right way.

Application 9: Develop students' confidence

An open and happy approach can make a noticeable difference in the quality of teaching. The students should work from a grounded state of equanimity. The project team should work in a harmonious and nourishing environment to achieve maximum results and fulfilment. Experienced data analysts can be brought into class as guest speakers (through physical or virtual presence) to help students develop a broader perspective. The student project team should be confident enough to receive help from unexpected sources. It should have the patience to assemble all the right data to approach the problem at hand, and to discover deep patterns in data.

Application 10: Gather and organize the right data

Assembling the right data is key to answering the research question. Data gathering, cleansing and structuring can be a laborious, semi-automated job that takes up to 80-90% of the time of a data analytic project. Answering complex questions requires finding data from many perspectives and domains. One should cast the net wide to include social media, devices, and other unstructured data to the mix of internal structured data. The raw data may come with various levels of quality, and may even be conflicting. Data will need to be cleansed, and possibly supplemented with additional dimensions, to help answer the research questions.

Principle 6. Dive in at the right angle for effortless success.

This principle clarifies the previous principle. Diving into a body of water at the correct angle produces effortless forward motion, while jumping in at the wrong way can be wasteful and hurtful. Diving into cleansed and organized data with the right models and tools can increase the chances of making the right discoveries. Thus, a systematic and correct dive into the data with full awareness is necessary to effortlessly and efficiently reveal valuable insights. The right strategy and an organized approach can have a huge impact on effectiveness, efficiency, and morale of the data analytics team. Automation should be used where possible to derive most results in the least amount of time and effort.

Application 11: Finding Great Patterns

Data Analytics is often described as the task of finding a proverbial needle in a haystack. Just as a skilled diamond miner knows what kind of a diamond to look for, a skilled data miner should know what kinds of patterns to look for. It takes domain knowledge and skill to know where the great patterns might be hiding. Patterns can be found at every level: at aggregate as well as lower levels. One should be fully aware for the insight to emerge at any time, and should look far and wide to find useful patterns. Sometimes the pattern may even be hiding in plain sight. Great patterns tend to have the qualities of being General, Accurate, and Simple (GAS). Einstein's equation, $E=MC^2$, is one such great pattern and an inviolable scientific principle. However, in social science analytics, one can typically aspire to achieve only two out of these three qualities in the patterns (Weick, 1979).

Principle 7. Established in Self, perform Action

This holistic principle relates to all of the previous principles, and brings the focus on the knower. Every person is the embodiment of the wholeness of Natural law (Maharishi, 1995). All knowledge ultimately is the knowledge of the self. The only thorough knowledge is that from direct experience. Natural Law should be enlivened in one's consciousness to evoke infinite power and creativity. One should be deeply involved in one's work, while still retaining a sense of detachment. One should not be anxious about the results, and be confident that doing the right thing will bring success, joy and fulfilment. The student and teacher should be confident and trust their own intuition and capabilities to do the right thing. This principle applies to many of the applications mentioned earlier including #9 on developing students' confidence. The students and teachers should be encouraged to practice some type of a meditation/mindfulness/self-awareness practice.

Implications and Conclusion

This paper addresses a new paradigm that is especially useful for teaching multidisciplinary subjects such as Data Analytics. All integration of knowledge happens at the level of the student's consciousness. Key principles around knowledge, process of knowing, and the knower, can help achieve this integration. This paper presented a few simple Natural Law principles as an integrative framework for Data Analytics education. This framework can bring joy and fulfilment to the teacher and students. The value of enlivening Natural Law extends beyond the time in the classroom, and can set the student up for success in her work life in the future.

Just like critical thinking skills are useful across life, so also Natural Law principles are applicable across life. Critical thinking and Natural law are complementary skills, that help to corrode ossified practices and help invent new and vibrant practices that align with the highest principles of Nature itself.

Enlivening Natural Law leads to the growth of self-awareness. It can be accomplished through meditation and other such practices. Students can thus learn to be more self-aware and be open to more possibilities.

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Appendix: Main Points and Unity Chart for Decision Trees

Wholeness: Decision Trees are a powerful, logical, easy-to-understand and versatile decision-making tool that can be used to represent knowledge extracted from a lot of data. NLP*: *Knowledge is structured in Consciousness.*

MAIN POINTS

1. Decision Trees are a classification technique that provide an easy way of solving problems in a consistent and logical manner. NLP: *Do less, achieve more.*
2. Decision Trees can be produced in many ways, using multiple algorithms, to maximize specific qualities such as accuracy, simplicity and generality. NLP: *Seek highest first.*
3. An ideal decision tree should be accurate, balanced, short, and easy to explain. NLP: *Dive in at the right angle.*
4. The decision-tree construction process should be open to alternative decision trees that may be equally or more accurate. NLP: *Truth is found in many ways.*
5. Building the sub-trees is a recursive process. One should ask the more important questions first. These are questions that would lead to maximum information gain. Repeat the process till leaf nodes or a stopping criterion is reached. NLP: *Life is found in layers.*
6. Decision Trees automatically select the most relevant variables, are tolerant of data quality issues and do not require much data preparation from the users. NLP: *Do less and achieve more.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

Decision Trees need broad vision and refined perception

1. Decision Trees are decision-making devices that capture the essence of previous data and help make better decisions.
2. The Decision maker finds bliss in effortlessly selecting the future path of action.

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3. Transcendental Consciousness is the field of pure knowledge – the field of infinite correlation in which everything is related to everything else.
4. Impulses within the Transcendental field: are the impulse of nature that give rise all decision processes.
5. Wholeness moving within itself: In Unity Consciousness, all knowledge and decisions and actions are but faint glimmers of the Self.

* NLP = Natural Law Principle