# THE PSYCHOLOGICAL EFFICACY OF EDUCATION AS A SCIENCE THROUGH PERSONAL, PROFESSIONAL, AND CONTEXTUAL INQUIRY OF THE AFFECTIVE LEARNING DOMAIN

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***ABSTRACT***

*This monograph provides a psychological rational for the novel field of "Educational Science" and how it conducts in–depth research investigations first presented in an article by the author in the i-manager's Journal on Mathematics through the trichotomous analysis of the affective domain. Educational Science uses the innovative Total Transformative Trichotomy–Squared [Tri–Squared] Test as a means of informative inquiry. This novel approach to data analysis is a mixed methods research design that involves the holistic combination and comparison of qualitative and quantitative data. An example is provided of the process of creating trichotomous instruments that are an essential part of the Tri–Squared Test.*

*Keywords: Data Analysis, Education Science, Eduscience, Instrument, Investigative, Psychometrics, Trichotomy, Tri–Squared, and Statistics.*

## INTRODUCTION

The Affective Domain refers to a classification of the different objectives that educators set for students (learning objectives). Bloom's Taxonomy divides educational objectives into three "domains": Cognitive, Affective, and Psychomotor (sometimes loosely described as knowing/head, feeling/heart and doing/hands, respectively). Within the domains, learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels (Orlich, et al, 2004). The term "affect" in this definition is derived from the science of psychology and directly refers to the individual experience of feeling or emotion as a result of some external stimuli.

The affective learning domain measures values, attitudes, perceptions, perspectives, motivations, appreciation, and feelings. These are driving forces that are essential to success in any endeavor, especially teaching and learning. Critical to the success of pedagogy and andragogy is the determination and motivation of the individual. This applies to all involved in academia, whether they are the teacher or the student, the school or the stakeholder, the administrator or the larger institution. Cognitive and psychomotor measures often provide tangible results; however, the affective domain offers a deeper insight into what individuals perceive as barriers or benefactors to academic success.

As stated by On the Cutting Edge: The Affective Domain in the Classroom Professional Development for Geoscience Faculty (a website dedicated to using the affective domain to teach the sciences), "As science faculty, we naturally emphasize the cognitive domain in our teaching. After all, students think and learn with their brains (we hope!). Yet the affective domain can significantly enhance, inhibit or even prevent student learning. The affective domain includes factors such as student motivation, attitudes, perceptions and values. Teachers can increase their effectiveness by considering the affective domain in planning courses, delivering lectures and activities, and assessing student learning (On the Cutting Edge, 2012)".

Measuring the affective domain literally means that the researcher adopts an understanding that the respondent makes a personal contextual association with the variable under study. This emphasizes that qualitative inquiry will provide a method of gaining much needed insight into what is actually occurring during the research. This unique insight provides a richer understanding of the cause and

effect of variables that have a direct influence on the learner from the learner's perspective. This greatly enhances investigative research and makes it much more relevant. Thus, the research provides greater insight and becomes very practical. The affective domain can be separated into traits that can become insightful variables that better aid with the development of a research design for qualitative inquiry.

### The Traits of the Affective Domain of Learning

The following "Affective Domain Table" can be used for the effective development of contextual affective domain traits. These traits can be used to employ the affective domain in teaching and research. In terms of trichotomy they can be used to create specialized instruments for affective domain inquiry. The Table determines affective domain traits through a series of personalized definitions, descriptions, and level of personal reflection that can each be separated into trichotomous categorical variables or trichotmous outcome variables for the purposes of in–depth affective domain analysis. Table1 is presented and a discourse on trichotomy follows.

| Affective Learning Domain Trait | Trait Definitions | Trait Descriptions | Trichotomous Level of Personal Reflection as: Low, Medium, or High |
|---|---|---|---|
| Feels | Loves, Hates, Appreciates, etc. | Personal interpretation through an emotion towards something | High |
| Reacts | Repulsed, Accepts, Engages, etc. | Personal interpretation of an immediate response to something Personal | High |
| Views | Thought Towards, Outlook On, Viewpoint Of, etc. | interpretation of mental outlook towards something Personal | Low, Medium or High |
| Values | Likes, Dislikes, Sure, Unsure, etc. | interpretation of the overall worth of something | Low, Medium or High |
| Describes | Beautiful, Symmetrical, Asymmetrical, Shapely, etc. | Personal interpretation of the aesthetic quality of something | Medium |
| Responds | Yes, No, Maybe, Affirmative, Negative, Uncertain, etc. | Personal interpretation as a response to something | Low |
| Characterizes | Good. Bad, Negative, Positive, Uncertain, etc. | Personal interpretation of the intrinsic qualities of something | Low |

Table 1. Affective Domain of Learning on Trichotomy

### The Origins of the term "Trichotomy"

The term is pronounced ['trahy-kot-uh-mee'], spelled "trichotomy", and is a noun with the plural written form "trichotomies". A "Trichotomy" in terms of philosophy can be referred to as a threefold method of classification. Philosopher Immanuel Kant adapted the Thomistic acts of intellect in his trichotomy of higher cognition — (i) Understanding, (ii) Judgment, (iii) Reason — which he correlated with his adaptation in the soul's capacities — (i) Cognitive Faculties, (ii) Feeling of pleasure or displeasure, and (iii) faculty of desire (Kant, 2007). In terms of mathematics, Apostol in his book on calculus defined "The Law of Tricohotomy" as: Every real number is negative, 0, or positive. The law is sometimes stated as "For arbitrary real numbers a and b, exactly one of the relations $a < b$, $a = b$, and $a > b$ holds" (Apostol, 1967).

It is important to note that in mathematics, the law (or axiom) of trichotomy is most commonly the statement that for any (real) numbers x and y, exactly one of the following relations holds. Until the end of the 19th century the law of trichotomy was tacitly assumed true without having been thoroughly examined (Singh, 1997). A proof was sought by Logicians and the law was indeed proved to be true. If applied to cardinal numbers, the law of trichotomy is equivalent to the axiom of choice. More generally, a binary relation R on X is trichotomous if for all x and y in X exactly one of xRy, yRx or $x = y$ holds. If such a relation is also transitive it is a strict total order; this is a special case of a strict weak order. For example, in the case of three elements the relation R given by aRb, aRc, bRc is a strict total order, while the relation R given by the cyclic aRb, bRc, cRa is a non–transitive trichotomous relation. In the definition of an ordered integral domain or ordered field, the law of trichotomy is usually taken as more foundational than the law of total order, with $y = 0$, where 0 is the zero of the integral domain or field. In set theory, trichotomy is most commonly defined as a property that a binary relation $<$ has when all its members $<x, y>$ satisfy exactly one of the relations listed above. Strict inequality is an example of a trichotomous relation in this sense. Trichotomous relations in this sense are irreflexive and antisymmetric (Sensagent, 2012). It is from

these logical and mathematical definitions that the author derives the definition of "Research Trichotomy" and applies it to the qualitative and quantitative analysis of the affective domain of learning.

### Defining "Trichotomy" in Terms of Affective Domain Inquiry

In terms of investigations that concern the affective domain the term "Trichotomy" is defined in the following threefold definition: (i) Separation or division into three distinct parts, kinds, groups, units, for the purposes of analyzing contextual attitudes, emotions, or perceptions; (ii) Subdivision or classification of some whole into equal sections of three or "trifold segmentation" as a process of inquiry; and (iii) Categorization or division into three mutually exclusive, opposed, or contradictory groups for the quantification of affective traits, for example – "A trichotomous analysis of the perception of symmetry, asymmetry, or non–symmtery." The use of trichotomy as a means of affective qualitative and quantitative data analysis is explored in education when it is viewed as a scientific field (Osler, 2012).

### Education as a Science

Education as a field has developed its own native intrinsic theories regarding pedagogy, andragogy, and knowledge transfer. Through tried and true methods it now requires in–depth investigations into the learning environment to make new discoveries that empower and enhance learning form Pre–K to Higher Ed. This requires a unique scientific methodology that is specific to education and has tools that take into account the unique requirements of education as a field study. Thus, "Eduscience" or "Education Science" now steps into the body of knowledge as a new field of inquiry and learning (Osler, 2012).

### Defining Education Science

The field of "Education Science" is also represented by the term "Eduscience" which is a portmanteau of the two terms "Education" and "Science". Similar to the field of "Bioscience", Eduscience is the study of education wherein applicable sciences (such as ergonomics, statistics, technology, etc.) are applied to enhance and improve learning. The primary purpose of the field of Eduscience is the study and application of solutions to improve and enhance the learning environment and learning in general. Eduscience is solution–driven and is actively concerned with the transfer and dissemination of knowledge. Education Science is a broad field and its professionals are directly involved in the field. Those who are actively involved in Eduscience can be referred to as "Education or Educational Scientists". Educational Scientists or "Eduscientists" are multifaceted professionals who have a variety of areas of expertise. They can assume multiple roles in the educational environment and can serve in a variety of offices and in a multitude of capacities (Osler, 2012).

### Education Scientists

The primary positions that Eduscientists assume in academia can be found in the following areas: Administration (as Leaders, Organizational Heads, and Organizational Management Professionals), Instruction (as Teachers, Professors, and Facilitators), Practice (as Practitioners in a variety Specified Areas and Arenas), and Technology (as Educational Technologists, Instructional Technologists, and Information Technologists). In these positions Eduscientists effectively use, analyze, study, and deploy novel instructional learning theories, methodologies, strategies, solutions, tools, and techniques in both traditional or virtual (pedagogical and andragogical) settings to bring about learning (Osler, 2012).

### The Goal of Education Science

Educational Scientists strive to make the process of knowledge transfer both transitive and transformational. A transitive and transformative knowledge transfer process is as seamless and as harmonious as possible in an effort to empower, enhance, and improve learning. Eduscientists are masters of teaching who also are highly proficient practitioners who are able draw from personal and professional experiences to make the learning environment more viable (Accessible), usable (Ergonomic), teachable (Instructional), engaging (Relevant), approachable (Adaptive), exploration–based

(Discovery), and inspirational (Transformative). The Total Transformative Trichotomy–Squared Test is a comprehensive multi–step research methodology that is employed by Eduscientists. It is especially designed to conduct qualitative and quantitative investigations in educational settings and the learning environment. One of the tools designed to conduct qualitative and quantitative inquiry is the Tri–Squared Test based upon Trichotometric Analysis.

### The Psychometrics of Trichotometric Analysis

One of the most challenging areas of research in education involves the construction of specific instruments that are designed to measure qualitative outcomes and data. Although there are a great many measurement tools that analyze the cognitive and psychomotor domains, there remains a vacuum in the number of instruments especially designed to accurately measure the affective domain (the learning domain that contains attitudes, opinions, emotions, perception, and perspectives). This void is further expanded when the specific event under investigation is unique, specialized, has specific characteristics, serious legal constrictions, and issues regarding time. This often requires the research investigator to design an instrument that ideally measures the variables under investigation.

The process of designing instruments for the purposes of assessment and evaluation is called "Psychometrics". Psychometrics is broadly defined as the science of psychological assessment (Rust & Golombok, 1989). The Tri–Squared Test pioneered by the author, factors into the research design a unique event–based "Inventive Investigative Instrument". This is the core of the Trichotomous–Squared Test. The entire procedure is grounded in the qualitative outcomes that are inputted as Trichotomous Categorical Variables based on the Inventive Investigative Instrument. The specific assessment of the variables is completely dependent upon the outcomes determined by the researcher's instrument. The creation, production, and deployment of the Inventive Investigative Instrument requires that the research investigator adopts the role of a "Trichotomous Psychometrician" or "Trichotometrician". A "Trichotomous Psychometrician" is an Educational Scientist that uses trichotomous–based psychometrics to develop a qualitative Inventive Investigative Instrument specifically designed capture qualitative responses during a specific event. A description of the entire Tri–Squared research process follows and is described in detail so that the reader is informed of precisely how an Inventive Investigative Instrument is developed, designed, and ultimately implemented.

### Efficacy of Affective Domain Trichotometric Analysis: The Tri–Squared Test

The Tri–Squared research methodology: A four step process for determining the appropriate Research Effect Size, Sample Size, and Alpha Level (Osler, 2012). The Tri–Squared research procedure consists of a four step approach designed to provide the researcher with a clear and precise set of data to conduct research, analyze data, and determine the level of significance required to either validate or reject the initial research hypothesis. The four Tri–Squared steps are as follows:

- Design of an Inventive Investigative Instrument that has Trichotomous Categorical Variables and Trichotomous Outcome Variables.
- Establish the Research Effect Size, Sample Size with associated Alpha Level.
- Establish Mathematical Hypotheses.
- Use the Tri–Squared Test as the Data Analysis Procedure following implementation.

### The Tri–Squared Research Design

***Step One***: Design of an Inventive Investigative Instrument that has Trichotomous Categorical Variables and Trichotomous Outcome Variables.

***Step Two***: Establish the Research Effect Size, Sample Size with associated Alpha Level.

The Tri–Squared Effect Size Formula

$$Tri^2_{Eff} = \left[T_{CR} - \left(T_C T_R : n_{Tri^2}\right)\right] : C_S R_S \left(n_{Tri^2} - 1\right)$$

***Step Three***: Establish Mathematical Hypotheses.

Sample Mathematical Hypotheses

$H_0$ : $\boldsymbol{Tri^2 = 0}$

$H_1$ : $\boldsymbol{Tri^2 \neq 0}$

***Step Four***: Use the Tri–Squared Test as the Data Analysis Procedure following implementation.

Sample Tables 2&3 of qualitative and quantitative data follow to illustrate how the Tri–Squared Test displays the outcomes of affective domain inquiry (Osler, 2012).

The Tri–Square Test Formula for the Transformation of Trichotomous Qualitative Outcomes into Trichotomous Quantitative Outcomes to determine the Validity of the Research Hypothesis:

$$Tri^2 = T_{Sum}\left[\left(Tri_x - Tri_y\right)^2 : Tri_y\right]$$

$Tri^2$ Critical Value Table = TBD (with d.f. = 4 at α = TBD). For d.f. = 4, the Critical Value for p > TBD is TBD. The calculated Tri–Square value is TBD, thus, the null hypothesis ($H_0$) is rejected by virtue of the hypothesis test which yields the following: Tri–Squared Critical Value of TBD < or > TBD based upon the Calculated Tri–Squared Value.

$n_{Tri} = 0$
α = TBD

| Trichotomous Outcome Variables | Trichotomous Categorical Variables $a_1$ | $a_2$ | $a_3$ | |
|---|---|---|---|---|
| $b_1$ | 0 | 0 | 0 | $= Tr_1$ |
| $b_2$ | 0 | 0 | 0 | $= Tr_2$ |
| $b_3$ | 0 | 0 | 0 | $= Tr_3$ |
| | $Tc_1$ | $Tc_1$ | $Tc_1$ | $= T_{Tri}$ |

$$Tri^2\ d.f. = [C-1][R-1] = [3-1][3-1] = 4 = Tri^2_{[\bar{x}]}$$

Table 2. A Sample 3 × 3 Table of the Qualitative Outcomes of the Tri–Squared Test

$n_{Tri} = 0$
α = TBD

| Trichotomous Outcome Variables | Trichotomous Categorical Variables $a_1$ | $a_2$ | $a_3$ |
|---|---|---|---|
| $b_1$ | $a_1b_1 = \frac{T_{r1}T_{c1}}{T_{Tri}}$ | $a_2b_1 = \frac{T_{r1}T_{c2}}{T_{Tri}}$ | $a_3b_1 = \frac{T_{r1}T_{c3}}{T_{Tri}}$ |
| $b_2$ | $a_1b_2 = \frac{T_{r2}T_{c1}}{T_{Tri}}$ | $a_2b_2 = \frac{T_{r2}T_{c2}}{T_{Tri}}$ | $a_3b_2 = \frac{T_{r2}T_{c3}}{T_{Tri}}$ |
| $b_3$ | $a_1b_3 = \frac{T_{r3}T_{c1}}{T_{Tri}}$ | $a_2b_3 = \frac{T_{r3}T_{c2}}{T_{Tri}}$ | $a_3b_3 = \frac{T_{r3}T_{c3}}{T_{Tri}}$ |

$$Tri^2\ d.f. = [C-1][R-1] = [3-1][3-1] = 4 = Tri^2_{[\bar{x}]}$$

Table 3. A Sample 3 × 3 Table of the Quantitative Outcomes of the Tri–Squared Test

The Tri–Square Test Formula for the Transformation of Trichotomous Qualitative Outcomes into Trichotomous Quantitative Outcomes to determine the Validity of the Research Hypothesis:

$$Tri^2 = T_{Sum}\left[\left(Tri_x - Tri_y\right)^2 : Tri_y\right]$$

$Tri^2$ Calculated Tri–Squared = [0] + [0] + [0] + [0] + [0] + [0] + [0] + [0] + [0] = 0 (with d.f. = 4 at α = TBD). For d.f. = 4, the Critical Value for p > TBD is TBD. Thus, we can reject the null hypothesis ($H_0$) by virtue of the hypothesis test if: Tri–Squared Critical Value of TBD < or > TBD based on the Calculated Tri–Squared Value.

Note: Comprehensive lists of Tri–Squared Tables are available that display and label Critical Values, Alpha Levels, and Sample Sizes based upon all calculated Tri–Squared Effect Sizes.

## Conclusion

The purpose of this paper is to provide support for the novel field of "Educational Science" and its associated measures from the psychological perspective of the affective domain of learning. A comprehensive description was given of the affective domain, educational science, trichotometric analysis, and the Tri–Squared Test to provide the rationale for the existence of Eduscience grounded in the educational psychology of Benjamin Bloom's Taxonomical definition of the affective learning domain. Examples were given of the Tri–Squared Test as a model of statistical measures that would be used in the field of Education Science for research. The implementation of Eduscience as a 21st Century educational field will empower educational researchers as "Educational Scientists" who will create novel methods of learning to empower 21st Century learners. Questions regarding education, pedagogy, and the process of learning will be made relevant through this new field of inquiry. "Eduscientists" will create and develop

instruments specifically designed to measure the efficacy of teaching, instructional strategies, and learning methods. In this manner the field of education will continue to grow, expand, and empower the present generation and future generations of learners.

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