

Outline of a Multidimensional Theory of Learning by Competences: An Essay about the Application of the Holospheric Learning System

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ABSTRACT: *There are several possibilities for understanding complex and polysemic terms such as Education and Learning. In this sense, over the last 30 years a theory of learning in particular has gained enough scientific status and reliability to serve as support for the implementation and regulation of education systems around the world: it is the Theory of Learning by Competencies. This theory, however, is subject to refinements and modifications, especially when confronted with scientific models such as Metaciência Social (created by Pablo Bispo dos Santos) and Unified Field Theory (created by Albert Einstein). This paper presents an essay to discuss the possibility of creating and applying (to several objects of study) a new methodology of educational evaluation called: Holospheric Learning System.*

Keywords: *Learning, Competences Theory, Multidimensional Theory of Competences, Holospheric Learning System*

I. INTRODUCTION

The objective of this work is to guide the construction of a Multidimensional Theory of Competence Learning (MTCL), in order to contribute to the improvement of learning assessment processes and the measurement of proficiency scores related to such evaluation processes. To do so, it is initially necessary to bring a Synopsis of Competence Theory. The theory of competences starts from the assumption that human learning is composed of two basic elements: Information + behavior / operative capacity. Both elements interact in the mind and demand of the individual (or group) the development of specific abilities for both.

With regard to Information, because it comes from outside the individual will presuppose the updating of the five senses; (External) and memory (internal). Both memory and sensitivity, in turn, have developmental abilities, which will be discussed below. Regarding behavior (henceforth called operative ability), it should be noted that its genesis lies in the interaction between the individual and the information that reaches the senses and is fixed in the memory. In addition, the operative capacity undergoes a gradual and continuous process of evolution, similar to a spiral being stretched towards limits not yet delimited.

Cognitive tests (ABC, Q.I, Q.E) at most point to indicators of the individual's operative capacity, not expressing accurately their abilities, much less intelligence and wisdom (superior and complex abilities, to the point of tending to be indefinable). Based on a Theory of Competences (Perrenoud, 2001) which is currently the most common in Education / Teaching. We need to take into account the following feedback loop: Information affects operative capacity (from contact with senses and memory) and the operative capacity in turn allows the individual / group to re-signify information, transforming it into a "useful knowledge and Applied", called competence.

II. ON THE OPERATIONAL CAPACITIES (CO): BRIEF DETAILS OF THE PRIVILEGED LOCUS OF THE APDZ

The O.C. according to the Theory of Competences have subdivisions that, if they interact in a hierarchical structural classification whose criterion is the complexity. In ascending order we have: Descriptors, Ability and Skills. Large educational programs use matrices of competence, which the more general they are in terms of their utterance, the broader their scope / spectrum. As an example: Since the year 2000, the UN (Delors, 2000) has set four competencies for the world education systems developed in the current millennium: Learning to know, Learn how to live, Learn how to do, and Learn how to be. As already explained, these competences are organized (as a rule) in a hierarchy of taxonomy by level of complexity. We are going to this classification and consequent subdivision:

A) Descriptors: minor cognitive elements. Expresses a O.C. immediately identifiable and with a level of complexity (in the context of the system for which they were created) minimum. For example, in a context of Competencies (C.T) of reading APDZ, a descriptor could be the ability to intensify letters, each of these descriptors would be grouped to other similar ones, forming a more complex block of O.C. denominated

Abilities (H). For operational and didactic purposes such descriptors (like the other elements) are codified. EX: Identify Letters = D1.

B) Abilities: integrate behaviors (O.C.) more complex. Returning to the previous example, a skill could be the reading of simple sentences, which would involve more than one descriptor. D1 + knowledge of syllables D2 + knowledge of word order D3. Together they would then form the required skill (H1). In terms of notation the format assumed by this integrating join would correspond to something like: $D1 + D2 + D3 = H1$.

C) Competencies: if the descriptor is at the information level and the skills are fixed (by priority) by the memory, the Competencies correspond to the understanding coming from the domain of groups of abilities. EX: (H1) literal comprehension ability of texts + (H2) reading skills in different supports + (H3) understanding of different connotations of writing = Reading competence (C1).

III. CORRECTIONS AND NEW ASSUMPTIONS FOR THE THEORY OF COMPETENCES

The basic assumption of competency theories is that it is possible to control *a priori* the scope of O.C. and informations contained in the Matrices of Competence (CM), which in turn are expressed in the Proficiency Scales (PE) such as the PISA (International Student Assessment Program, accredited by the OECD). However, it is necessary to consider a range of factors that intervene in this learning process (which in turn from biological / neurological causes to social, cultural and historical causes). Among these factors, there is one that deserves special consideration and which refers to a consequence of the process of consolidation of competences: the construction of Negative Competences (NC), which would take place from intervening learning paths (with respect to the Abilities) and dissonant behavior (an integral part of the NC) that refers to the descriptors.

3.1- The Nature of Learning: Desirable knowledge, undesirable knowledge and cognitive interferences

The theory of Competences is basically anchored in the aforementioned prior selection of the scope of information, extracts codified from O.C., and in tests whose scores are measured on proficiency scales. However, it is necessary to question how much the learning itself when applied to other objects of knowledge foreign to the teaching program that originated the matrix of competences in question.

This is due to the fact that it is possible (but difficult) to force attention but it does not interest him as Santiago Hernande Ruiz said in Psychopedagogy of Interest (Ruiz, 1973). Thus, as the ability to learn is greater than (at least many of them) the teaching programs that give rise to the blocks of competences it becomes necessary to consider that undesirable knowledge "intervenes with variable level of probability (according to the previously listed individual factors) to consolidating desirable skills. Thus, it should be pointed out that there will be, to a greater or lesser extent, "competing" cognitive interference, consolidating unforeseen and / or undesirable competences. I call these negative competences (CN).

3.2- Negative Competencies: Genesis, Development, Consolidation and Impact

Similar to the consolidation of competences, skills and descriptors a process of "building" negative competences (equally hierarchical and grouped in skills and descriptors) takes place. This process will have more "force" the greater the following factors: A) time related to the consolidation (deviant) of negative competences (NC), B) interest in the competencies (P.C.) or N.C. in the teaching program; C) influence of environmental factors that distract the attention of the individual.

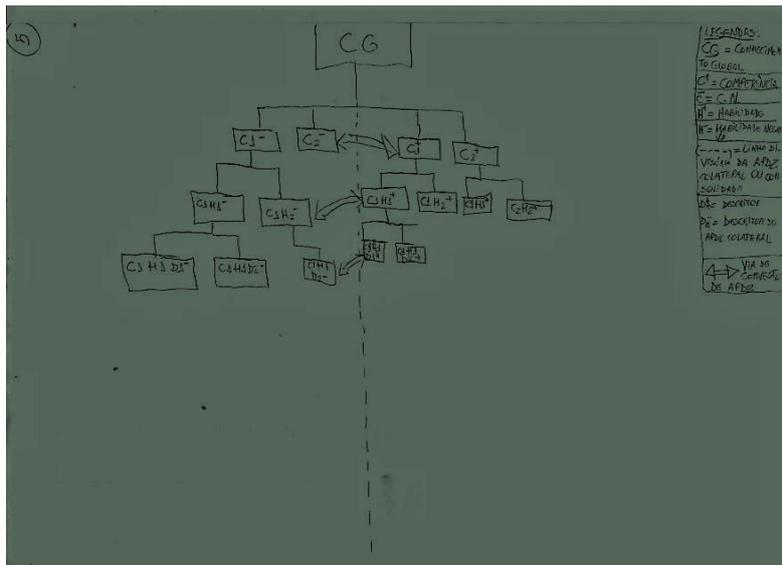
When this set of factors is taken into account. It is clear that in any education program the NCs should be estimated as to their impact. But how to estimate the NC? The answer lies in the parametric indicators that keep analogy with the structures of the proficiency scales, but they have a different form for O.C. (and sometimes even for information) and are expressed as "deviations" generally perceived as cognitive deficits.

3.3- Measurement of Negative Competences (NC): Direct and Collateral Learning.

Assuming a TA designed for the development of competencies (C +) linked to learning and taking into account what was put in relation to the (often collateral) development of the CN (or, if we prefer, C-), then we have to consider at A structure symmetrical to that of C +.

This symmetry then allows analytical level analysis (at least) in two scopes of analysis (C + and C-), allowing better estimation of the multidimensional (and multivectorial) impact of AT taking into account the unfolding of this holospheric learning system. Three possible graphic schemes for this system should be recognized. As an illustration will be presented a two-dimensional chart called the Competency Tree¹.

1 **Figure: Example of Competencies Tree (Hand drawn).** SUBTITLES: CG = GLOBAL KNOWLEDGE, C + = COMPETENCE, C - = NC, H + = SKILLS, H - = NEGATIVE SKILL, ----- = COLLATERAL OR CONSOLIDATED KNOWLEDGE SPLIT LINE, D + = DESCRIPTOR OF LEARNING, D - = DESCRIPTOR OF COLLATERAL LEARNING, ⇔ = WAY OF LEARNING CONVERSION



IV. POSSIBILITY OF CREATING A HOLOSFERIC LEARNING SYSTEM (H.L.S.)

The famous Pierre Bourdieu said in the 1980s: "Real is relational." From this premise the illustrious sociologist developed a Logical Theory that was based on two pillars: A) The concept of Field (Bourdieu, 2003): starting from the Unified Field Theory (Weinberg, 1996) he applies to the social sciences the notion of forces. This notion concerns an electromagnetic space in which the charges move according to their polarity and their potential. This displacement occurs in parallel lines (curves) parallel to the forced electric current that goes from the negative pole to the positive in a logical way: the field is the whole of society; The electric lines represent displacements in the "normal" sense referring to the displacement according to the direction of the Power², according to the rules of the field. The magnetic lines refer to the social displacement of the agents (groups, institutions, individuals) from their "choices". Such displacement would occur in the same sense as the magnetic lines, the field projected in a multidimensional and coplanar perspective.

The displacement of the agents (such as that of the magnetic field loads) depends on three basic factors: 1) *Potential of loads*: the greater, proportionally greater the probability of reorientation of the trajectory out of the direction of the "inertia" of the field; 2) *Induction Potency of Field (s)*: the stronger the induction potential, the greater the "inertia" of the field with respect to the trajectories of the agents that follow with minimum deviations their projected forces; 3) *The existence of the Social World*: according to this notion, there is a reality with materiality (in *Princípios da Metaciência Social* (Santos, 2013) is demonstrated the veracity of the logical and epistemological points of view) called social world. Its range is total and with variable geometry. Its structure would resemble the sphere with infinite planes within, which interpenetrate and influence such fields would then relate to the various dimensions of social life (politics, economics, education, law, fashion, culture and etc ...) and their spaces are Delimited both by the geopolitical coverage of events and by the historical effects of the mentality of the time. Based on these theoretical foundations and the unfolding of the *Princípios da Metaciência Social* (Santos, 2013), we have an application of this Social Theory to the Learning Competencies, which corresponds to H.L.S.

4.1- The H.L.S. And its links with the Social World: structure, matter, and form of competency learning

As indicated earlier, there are several possibilities for representing the development of PC and NC. The competency tree is an example of (two-dimensional) analysis of PC and NC. However, it is necessary to consider the multidimensionality of the learning (that of its cognitive unfolding) and for that, the field model lends itself to this purpose, giving rise to H.L.S.

4.1.1- The H.L.S. and its structure: Field lines and position systems from the learning by PC and NC.

The H.L.S. from a structural point of view arises from the mapping of learning (expressed in PC and NC) of the agents whose evaluation is incident on them. Thus, the system as predicted is divided into positional coordinates (APE) whose structure can be correspond to the following notation:

² This term is understood as the ability possessed for someone to do (or fail to do) something (Santos, 2015).

A) Expected Learning (APE): represented by the X and Y axes of the Cartesian plane placed in the center of the sphere. In this case, X is the coordinate relative to information and Y is the coordinate referring to O.C.

B) Observed Learning (APO): represented by the quadrant system of the circle and that is crossed by the lines of force of the field. As regards the quadrants formed by "X" and "-Y" there is the expression (in score) of NC and the quadrants "x" (or "+ X") and "Y" (or "+ Y") there are The expression of PCs taken as a "moment" of the field of learning. In the case of power lines, they express learning movements (relative to NC or PC) and are as follows: 1) *Intermittent behavioral conversion (LC-) lines*: + Y axis and -X; 2) *Lines of cognitive entropy (LEC-)*: positions of the -Y axis and - X PC learning line axis positions + Y and + X; 3) *Lines of behavioral consolidation positions of the -Y + X axis*.

C) Trajectory (TR): the trajectory corresponds to the resultant between the vectors formed by the APE and APO, this is a quantity taken as a function of a time T. Exposed T in line we have consolidated TR from moment X (with negative coefficient). Thus, for every previous RT in the field there will be a correspondence of a number from the following notation: $(-TX = TR)$, where $TR = (APE * APO) * (-TX)$ should be emphasized that when assigning value Negative to the temporal magnitude T, nothing else was done besides indicating that it is possible to identify the priorities of the trajectory of the agents in the H.L.S. "field" as from the same ones execute projections of other "moment" of the H.L.S. according to the agent. It should be noted, however, that such predictions will follow the increasing proportion of the complexity of factors linked to the projective analysis of the trajectory. With regard to TR, it should also be noted that the formula for a positive T can be detailed up to the first level of the notation. $TX = TR$, where $T = APE * APO$. Beyond this detail a series of intervening variables should be explained and weighted.

4.1.2 - The vectors of the H.L.S. and its various levels of detail, subject and form of the learning of CG (PC and NC)

H.L.S. composes its structure in quadrants crossed by field lines and by trajectory vectors that are the result of the interaction between the agents and the field lines. All these elements integrate a dynamic system whose shape is the sphere and whose becoming obeys to the movement of the spherical motor, which, in turn, due to the rotational omnidirectionality of its displacement leads to the construction of a double analogy referring to the term "holospheric".

The first concerns the projection of vectors from the rotational omnidirectionality of the spherical motor rotation. In this sense, because it contains a spherical shape (solid whose angles and sides tend to infinity). That is the geometric representation of totalities and to contain vector with omnidirectional projections, so the prefix *Holos* is applied to signify totalities in the archaic Greek. The second analogy concerns the fact that H.L.S. is a possible application of the unfolding of the concept of the social world (Bourdieu, 2001), which were developed from the logical and epistemological points of view in the *Princípios da Metaciência Social* (Santos, 2013), so the holospheric term applies by the possibility of applying (If not all) fields of the society (s), redounding in a theoretical-methodological perspective that aspires to the totality (or holistic if we prefer). Thus, the matter from whose substance the theoretical-methodological elements were hauled is the holosphere generated by the spherical motor, combined in its turn with the notion of field. Let's go to the shape of H.L.S. Regarding the shape of H.L.S. (Understanding matter and form according to the Aristotelian distinction, it unfolds in (at least) three basic levels: vector (macro), matrix (meso) and infra-matrix / positional (micro), which demand specific forms of As this is an absolutely complex and dynamic system, the interaction of the three levels demands time and material and intellectual resources proportional to the volume of data coming from this enormous cross-referencing of indicators, Scores and variables.

4.2 -Description of analytical levels of H.L.S.

The following is the detail of each level with respect to its function in H.L.S. (Although it is considered that levels are in constant interaction).

4.2.1- The Vector Level

At this analytical level the focus is on the assignment of information (INF) and C.O on the X, Y axis, as well as the determination of the quadrants and the field lines. As an example of possible investigation at this level we have the vector difference between LEC- and the + Y and - X axis, from the point of view of the resultant vector that would influence a (probable) trajectory of the agents in H.L.S. Determined. The learning vectors still express the difference between: APE-APO. Metaphorically, the vector level reaches mainly the holospheric "surface".

4.2.2 - The Matrix Level

The quadrants and the vectors alluding to them have a matrix structure. These matrices are the codifications of the S.H.A. CG decomposing into their component structures at a decreasing level regarding hierarchy and taxonomic generalization (recalling): C + (PC) and C- (or NC); The unfolding in H +; And / or H-; And their ramifications in their various D + and D- (as all can be seen in the following figure). The quadrants (as seen) generate dynamic vector projections which are derived from static components which are C + and C- concerning the dimension Vector (dynamics) insofar as the competence trees are placed as core elements of the H.L.S.

4.2.3- The Positional Level

Just as the vector level allows estimating the HLS, the infra-matrix / positional level allows us to locate and locate the agents at their "time" of time "T" in the field from their CO and INF. The positional level, in addition to the static and dynamic influences of H.L.S. Receives the influence of an element derived from these instances: the scale of proficiency. The levels of proficiency are represented by the achievement (by the agent) of successive consolidations (ranging from descriptors to competencies). Among these levels are defined levels of measurement of such proficiency that are expression of the INF and CO owned by the agent. In H.L.S. This variation occurs from the division into dotted concentric circles that run through the four quadrants.

When translating into metaphor, the positional level refers to the different possible points in which the agent can be located at a time "T". This closes the study of the matter, form and structure of H.L.S. The following will present a study about the vectors and forces involved in this system of learning evaluation.

V. THE H.L.S. AS A MULTIDIMENSIONAL SYSTEM FOR ASSESSMENT OF POSITIVE COMPETENCES (PC), NEGATIVE COMPETENCES (NC), LEARNING PATHS (T.A) AND INDIVIDUAL TRAJECTORIES (TIN): PROJECTIVE ANALYSIS

As an unfolding of the theoretical foundations presented, there is an effort to (at least) outline a multidimensional system of assessment (and evaluation) of learning elements related to competences, learning paths and trajectories (individual or group). Let us then move towards vector notations.

5.1 - Vector (Multi) Dimensional Ratings

The field concept presents a three-dimensional perspective of the system. In this three-dimensional perspective we have: 1) An X and Y coordinate system where X is = information volume and Y = O.C.; 2) Quadrats 1 and 3 represent positions concerning trajectories whose NCs consolidate most strongly; 3) Quadrats 2 and 4 relate to trajectories in which PCs consolidate more effectively.

The quadrants, because they obey the Field model, are crossed by lines and curves, parallel and perpendicular to the projected two-dimensional space. Thus, we have: A) lines that express the projection and TA (related to NC or CP) and positioned as (X) {intersection} f (y); B) curves (orthogonal or perpendicular that express with $T = f(X)$ {intersection} f (y).

As a consequence of the unfolding of the theoretical (Social Science) junction between the extended perspective of the theory of competences and the system of positions derived from the field theory, we have the following vector notations: A) The learning paths have structural regularity (due to previous structuring) in blocks of competences, the trajectories (to some extent) foresee irregularities concerning the learning of O.C. expressed in PC and or NC; B) There are two graphing systems that can be used in this multidimensional theory of learning: 1) The "Tree of Competencies" system, which hierarchizes and organizes (two-dimensional) the "D", "H +", "H", "PC" and "NC" and from which are systematized, and mapped Desirable and irrelevant knowledge; 2) The three-dimensional system (field) that is a function that expresses the trajectory of the subjects in relation to the projected learning track.

5.2- Displacements in the system of three-dimensional positions: Learning Path (TA) X trajectory observed (T.O)

In order to deepen the detail of H.L.S. It is necessary to highlight its main points: 1) In the case of a vector system, its displacements obey the basic structure of some concepts of physics, especially the kinematic Force, Vector Acceleration, Work, Mass, and Quantity of Motion becomes Crucial for the displacements to be measured (by analogy) ; 2) Then developing the analogy, we have: | The vector acceleration (AV) and the angular velocity (VA) allow us to understand the direction and direction of the displacement.

Force (F), Moment (M) and momentum (Q) express the probability of movement of the individual in the field, as well as allow estimation of inertia. The equation describing the amount of motion (Q) is analogous to that of physics: $Q = (M * V) -VA$. It is necessary to be added the angular velocity because it is a vector system in order to complete the analogy, we then have the following elements translated into positions in the Holospheric Learning System (H.L.S) especially with respect to Q then we have: 1) M = Mass = Consolidation

skills; 2) Scalar speed = proficiency score in relation to projected $T > A = V$; 3) Angular velocity = resulting from the interaction of the forces of H.L.S. expressed in the relationship between M and the interaction lines.

As a consequence of this quantity, we have to consider that $Q \Leftrightarrow W$, that is, momentum, is related to angular acceleration from the following notation:

$$\begin{aligned}W = 0 &\Rightarrow W = Q \\W \Rightarrow 0 &\Rightarrow W > Q \\W = 0 \Leftrightarrow W < Q\end{aligned}$$

As in kinematics, the velocity variations that make up the acceleration follow the formula: $Q = \Delta V / \Delta T$. As a consequence, vector acceleration (AV or W) obeys the following formula: $W = a.v$, where v = velocity X angle of the displacement that results in the trajectory.

In this way, W will be the measure from which learning (in terms of PC or NC) varies with respect to its consolidation (especially with respect to O.C.) in a time interval X. When taking into account what has been exposed, it is necessary to bring to light the "matter" whose "form" is expressed in these systemic relations derived from Q and W: 1) Q represents the proficiency measured by H.L.S. And expressed in PC e and NC; 2) W represents the deviation formed by TO in relation to TA, which necessarily refers to cognitive interferences (and the measurement of its force) in order to promote deviations from the generative PC (or NC) of the X, Y (-X, -Y) of the quadrants in which W is calculated.

As for the variable F, it also keeps an analogy with Q, insofar as Q is a function of F ($Q = f(F) X$) since F represents the vector component of the motion potential brought by the field. In other words, F is inversely proportional to the inertia of H.L.S. (hereinafter referred to as i). The formula of F is then: $F = V * W * \sin$, where V = velocity observed in ΔT (always regressive, never projective) measured in numerical quantities correlated with proficiency score X, disregarding the variation at $W =$ vector acceleration Of the displacement resulting from the difference (TA-TO axis) $Sen = TA.T / TO$, where TA = the learning path projected and measured by the average proficiency scores and the observed (and deviant) trajectory of the learning, also measured by Proficiency scores, but these are quantified in current or projective T in the HLS

The variable M stores analog relation with the physical concept of moment and expresses the result of the field forces. This result is expressed in three possibilities (with respect to the information with i):

$$\begin{aligned}M > i &= \text{motion generation (Q and F with positive coefficient)} \\M = i &= \text{motion imminence (Q and F with coefficient = 0)} \\M < i &= \text{absence of motion (Q and F tending to zero)}.\end{aligned}$$

The coefficient M, as seen, then expresses a particularly important magnitude to understand periods (ΔT) in which "stagnation" occurs in the learning scores and consequently in the PC + PC- consolidation processes. In terms of notation we have: $M = R / Pi$, where R is the sum of the motion components (forces in motion) of H.L.S. and Pi binds to the inertia potential estimated by forces contrary to the movement. In other words (and in another dimension I would say) Pi is maximum when the value of NC- (or PC +) as the case is equivalent to its score in the opposite quadrant (or the Cartesian axis when the very rare condition in which TA = TO). (For example): the more symmetric the trajectory performed by an agent B in the quadrants X + Y- and X-Y +, the greater will be Pi, since the displacement values tend to a "reconversion" In a period of ΔT is expressed as "stagnation" of the O.C.

VI. CONCLUSION

In terms of science (especially with regard to human sciences), it is not necessary to speak of definitive, ready and finished results. The movement of successive approximations to the reality realized by the scientific advances consists precisely in the deformation of the theoretical models previously established in order to fit the most recent (and precise) data from the empirical instance, thus promoting the necessary modification of the theoretical foundations previous to this process.

Therefore, it should be emphasized that the paper presented in this paper is not intended to exhaust the possibilities of applying the Multidimensional Theory of Competences, not to discuss all the theoretical and epistemological foundations of future Holospherical Learning System (HLS) applications. However, the foundations of a conceptual framework that could contribute greatly to the evolution of learning assessment systems have been launched, especially with regard to the projective analysis of the scores of the education systems in relation to PCs expected by Managers of education systems.

Last but not least, it should be pointed out that, based on concrete applications of this methodology integrated by H.L.S. The Multidimensional Learning Theory will also suffer the necessary "deformations" of its theoretical model in order to become more and more precise in future moments.

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