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Prompting Learners' Active Participation in an EFL Class

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I. Reticence in EFL Participation

Reticence, or passive participation in an EFL classroom, has long been a common phenomenon and has received growing attention in recent years (Burgoon, J., & Koper, R,1984; Zou, 2004). While some EFL learners have been used to being listeners in learning other subjects (e.g., math, physics, history, and what not), these EFL learners are still reticent in language classrooms (especially for speaking and listening related subjects) where active participation and interaction are essential. Reasons behind such a reticence can be: fear of losing face, low proficiency in the target language, previous negative experiences with speaking in class, cultural beliefs about appropriate behavior in classroom contexts, incomprehensible input, habits, lack of confidence, and personality (Zou, 2004; Miller & Aldred, 2000). Among these reasons, passive habits can be significant in that other factors such as low proficiency, incomprehensible input can be neutralized by posing questions for clarification (active participation), while personality factors (such as introversion) or lack of confidence is a matter of quantity of response, which may have little to do with reticence, and is not the focus of what the English instructors are concerned (Liu & Jackson, 2007).

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This paper thus seeks to explore the phenomenon behind reticence (mainly on habit formation) through a mathematical model, and suggests solutions to the problem. In what follows, Newtonian's laws will be adopted as a ground rationale, followed by the application of existing learning theories (such as Vygotsky's constructivism, and Skinner's operant conditioning, Bloom's learning objectives) on the bases of the operations of partial derivatives in mathematics.

II. Reticence as a Function of Inertia

Students' reticence in an EFL classroom can best be analogized as a state of inertia, which is the first law in the framework of Newtonian's classical mechanics. *That is, the velocity of a body remains constant unless the body is acted upon by an external force.* By analogy, every student, as well as the teacher, persists in his state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by force impressed. In the EFL classroom settings, reticent students will remain reticent until a positive force (impact) is received, whereas the active student will remain active until a negative force acts on him. Mathematically stated:

$$\sum F = 0 \Rightarrow \frac{dv}{dt} = 0 \qquad (01)$$

(F - the total extra force that acts on the individual, dv- the derivative of velocity, and dt - derivative of time (acceleration). This tendency of objects in nature to want to remain in the same state and to resist any changes unless the object is forced to do so is called the inertial property. The inertial property then is the resistance to change; the object will not change unless it is forced to or somehow motivated by attractive or repulsive effects to change (Dean Hamden, 2009). How much attractive or repulsive force is needed to cause effects to change is another issue, which has to do with the second Newtonian law. Hence the second law: The acceleration of a body is parallel and directly proportional to the net force F and inversely proportional to the mass m, i.e., $F = ma$. The mass can be taken outside the differentiation operator by the constant factor rule in differentiation. Thus,

Global Journal of Human-Social Science (G) Volume XV Issue XI Version I Year 2015

$$F = m\frac{dv}{dt} = ma \qquad (02)$$

(where F is the net force applied, m is the mass of the body, and a is the body's acceleration.) Thus, the net force applied to a body produces a proportional acceleration. In other words, if a body is accelerating, then there is a force on it. By analogy, students' performance in class, either active or passive (as reticent), can be the function of their strength of *inertia.* Here *duration of inertia* can be one of the estimators of the strength of inertia; thus the longer the duration of inertia, the stronger it is. Therefore, the minimum amount of attractive or repulsive force to counteract or change original inertia must be greater than F. The acceleration, a, also be seen as *F* divided by *m.* Thus, the more *F* is, the more *a,* and the more *m*, the less *a*, when *F* is fixed. By analogy, if a student's being reticent in class has become a trait (long duration of inertia, thus large *m*), then the instructor will have to exert *F*, strong enough to counteract *m*, to create any desired effect *a*, (i.e., toward being more active). It is worthy of note that F can be both the attractive and repulsive force, with the former moving students toward being active in class, while the latter toward being even more reticent on the part of students. Yet, the teacher can also respond differently after exerting F onto learners, depending on the effects of the F. If F is the attractive by nature, then the teacher will also receive such a force (as encouragement or reinforcement for next moves), and vice versa, which can also be suggested by the third Newtonian law.

As the Third law indicates: The mutual forces of action and reaction between two bodies are equal, opposite and collinear. That is, to every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts. Specifically, whenever a first body (the teacher) exerts a force F on a second body (the student), the second body (student) exerts a force −F on the first body (teacher). F and −F are equal in magnitude and opposite in direction. This law is sometimes referred to as the action-reaction law, with F called the "action" and −F the "reaction". The ac tion and the reaction are simultaneous. Note also that though the forces are equal, the accelerations are not: the less massive body (e.g., student) will have a greater acceleration due to Newton's second law. The third law can be stated mathematically as follows:

$$\sum F_{a,b} = -\sum F_{a,b} \qquad (03)$$

(Where Fa, b are the forces from B acting on A, and Fb, a are the forces from A acting on B.)

The variables *F, m,* and *a,* in Newtonian laws can be very complicated, each of which has manifolds. *F* and *m* are the cumulative forces from instructions inclusive of teaching/learning methods, material inputs/output, activities, tests, teaching/learning styles, teaching/learning objectives, and the like, whereas *a* can be a dependent measure of the ratio between *F* and *m*. The multidimensional nature of the instructional settings can best be mathematically reflected through the concepts of partial derivative, integrative, and matrix. In the following the relationships among the three main educational objectives as initiated by Bloom's taxonomy will be interpreted mathematically.

a) Bloom's taxonomy

Benjamin Bloom (1956) identified three domains of educational activities: Cognitive: mental skills (Knowledge), Affective: growth in feelings or emotional areas (Attitude), and

Psychomotor: manual, physical skills or motor responses. Much later, Anderson and Krathwohl (2001) modified Bloom's original model and proposed six sub-categories of cognitive domain (from simple to complex in the hierarchy below): *remembering, understanding, applying, analyzing, evaluating, and creating*. There is hierarchical nature among the sub-categories. Note that students' creativity is the ultimate objective of instruction in cognitive domain, but in order to help students reach such a goal state, the teacher needs to lead students to go through *remember, understand, apply, analyze and evaluate* what is learnt. The affective domain is more concerned with *values*, or more precisely perhaps with *perception of value issues.* The affective domain also manifests subcategories from *Receiving, Responding, Valuing, Organizing and Conceptualizing*, to *characterizing by value or value concept*. Students will have to display their willingness to learn by *receiving*, before they can do the *responding*, and then learning can gradually become part of students' *value system* on the basis of *value organization and conceptualization*. Lastly, the psycho-motor domain also manifests subcategories from *imitation, manipulation, precision, articulation, to naturalization* (Dave, 1975). Theoretically, dynamic relationships exist at least in the three domains, and in the sub-category of each domain. There is mutual interdependence among these three domains. In other words, instruction or learning as a whole must include these three components to be effective and meaningful; success in one component must be supported by success in the other two components but with different proportions. In the following, the possible combinations in terms of success (desirable: +) and failure (undesirable: -) in each of the three domains (cognitive, affective, and psycho-motor) will be described to reflect "reticence' mathematically, followed by more complex mathematical operations on the inter-relationships of these three components.

III. Partial Derivatives of the Three Components

If the three components (cognitive, affective, psychomotor) can be given a positive value [+], or a negative [-], each of which represents a desirable or undesirable state, respectively. For example, the values [+, +, -] represents the situation when learners' cognitive state is positive (desirable), affective positive (desirable), whereas psychomotor negative (undesirable). Then, all the possible combinations can be listed as:

Case 1: [Cognitive +, Affective +, Psychomotor +]
Case 2: [Cognitive +, Affective +, Psychomotor -]
Case 3: [Cognitive +, Affective -, Psychomotor +]
Case 4: [Cognitive -, Affective+-, Psychomotor -]
Case 5: [Cognitive +, Affective -, Psychomotor -]
Case 6: [Cognitive -, Affective -, Psychomotor +]
Case 7: [Cognitive -, Affective -, Psychomotor +]
Case 8: [Cognitive -, Affective -, Psychomotor -]

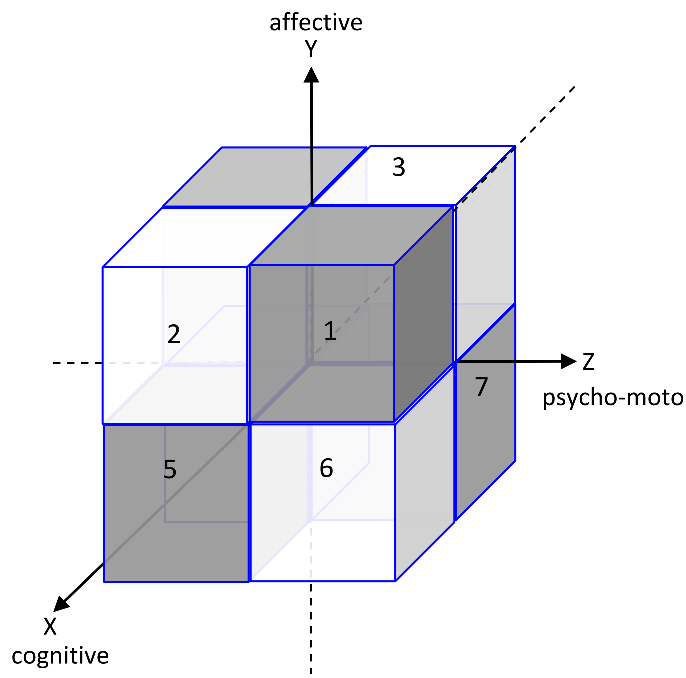

Figure 1 : Eight phases of three domains

Among the above 8 Cases, EFL learners under Cases 2, 4, 5, 8 can be categorized as reticent in that their psycho-motor aspects (oral performance) are not desirable. However, what can EFL instructors do to improve the situations? As indicated from the negative value sign (-), EFL learners under Case 2 must receive instructions that focus on psycho-motor aspect, focus on both affective and psychomotor aspects under Case 4, focus on both cognitive and psychomotor under Case 6, and lastly, focus on all the components (cognitive, affective, psychomotor) under Case 8.

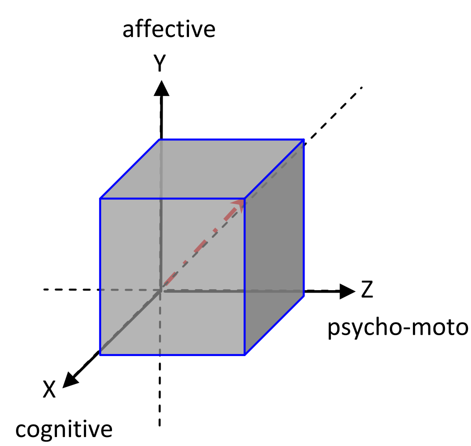

Figure 2 : The three domains on Phase One

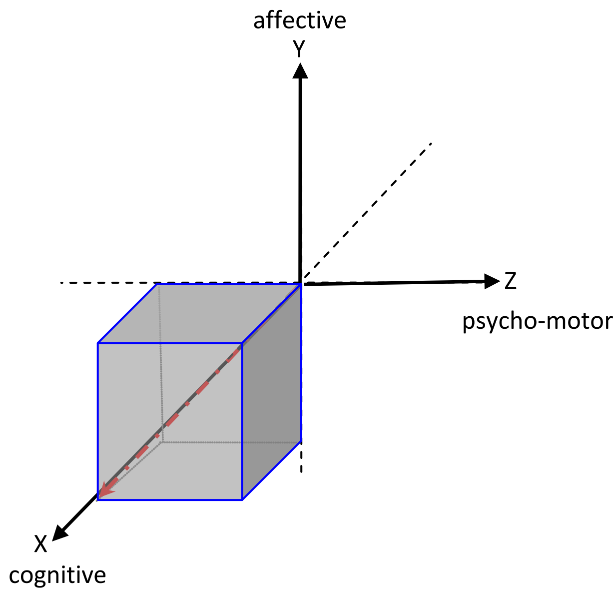

Figure 3 : The three domains on Phase Five

Since these three components make up the learning status with each one independent of the others, it is convenient to conceive them as a vector with three different coordinates. Their interrelationships can be further elaborated through the operations of vector calculus and vector integrals. Such an attempt is to further explore the relative strength of the three components in terms of different proportion of rate of change, which helps provide a guideline for instructors to give the optimal instruction that is based on the principle of 'equilibrium' among the three components.

In general the states of the three components in a given situation can be specified as (Holzner, Steven, 2005):

$$\langle \frac{\partial F}{\partial cog}, \frac{\partial F}{\partial aff}, \frac{\partial F}{\partial motor} \rangle \tag{04}$$

(Where F- a given learning or instructional state, ∂cog - partial derivative on cognitive aspect, ∂aff - partial derivative on affective aspect, $\partial motor$ - partial derivative on psycho- motor aspect.)

In order to explore more of each of the components along with their relative values, we will adopt some useful operations such as: ∇ (del), ∇F, $\nabla \bullet F$, $\nabla \times$F and so on. First of all, we will illustrate the rate of change of each component in terms of the mathematical symbol as:

$$\nabla F = \langle \frac{\partial F}{\partial cog}, \frac{\partial F}{\partial aff}, \frac{\partial F}{\partial motor} \rangle \tag{05}$$

An important example of a function of several variables is the case of a *scalar-valued function* $f(x_1,...x_n)$ on a domain in Euclidean space R^n (e.g., on R^2 or R^3). In this case f has a partial derivative $\partial f/\partial x_j$ with respect to each variable x_j. At the point *a*, these partial derivatives define the vector

$$\nabla f(a) = \left(\frac{\partial}{x1}(a), \frac{\partial}{x2}(a), ... \frac{\partial}{xn}(a) \right) \tag{06}$$

This vector is called the gradient of f at a. If f is differentiable at every point in some domain, then the gradient is a vector-valued function ∇f which takes the point *a* to the vector $\nabla f(a)$. Consequently, the gradient produces a vector field.

This expression also shows that the computation of partial derivatives reduces to the computation of one-variable derivatives.

$$\nabla = \left[\frac{\partial}{\partial x}\right] i + \left[\frac{\partial}{\partial x}\right] j + \left[\frac{\partial}{\partial x}\right] k \tag{07}$$

a) Level of Curl

It is also important to know just when changes (level of curl) in any of the three components (cognitive, affective, and psycho-motor) will occur. Since these three components are interdependent, with triad relationships, changes in one component are subject to the relative strength of the other two components. For example, changes of cognitive component (from desirable to undesirable) depend on the relative strength of the other two components (affective and psycho-motor). In vector calculus, $[\nabla \times F]$, referring to the level of curl, can offer good reference for understanding componential changes in F. Let's assume the three coordinates x, y, and z, as denoted below:

$$\langle \nabla \times F \rangle z = \nabla xFy - \nabla yFx = \frac{\partial Fy}{\partial x} - \frac{\partial Fx}{\partial y} \tag{08}$$

$$\langle \nabla \times F \rangle x = \nabla yFz - \nabla zFy = \frac{\partial Fz}{\partial y} - \frac{\partial Fy}{\partial z} \tag{09}$$

$$\langle \nabla \times F \rangle y = \nabla zFx - \nabla xFz = \frac{\partial Fx}{\partial z} - \frac{\partial Fz}{\partial x} \tag{10}$$

Accordingly, replace x with [cog] (cognitive component), y with [aff] (affective component), and z with [motor] (psycho-motor component), respectively, then we have,

$$\langle \nabla \times F \rangle motor = \nabla cogFaff - \nabla affFcog = \frac{\partial Faff}{\partial cog} - \frac{\partial Fcog}{\partial aff} \tag{11}$$

$$\langle \nabla \times F \rangle cog = \nabla affFmotor - \nabla motorFaff = \frac{\partial Fmotor}{\partial aff} - \frac{\partial Faff}{\partial motor} \tag{12}$$

$$\langle \nabla \times F \rangle aff = \nabla motorFcog - \nabla cogFmotor = \frac{\partial Fcog}{\partial motor} - \frac{\partial Fmotor}{\partial cog} \tag{13}$$

The meaning of any of the above equations, to take Equation (09) for example, is: the level of curl, [$\nabla \times F$] is the difference between [$\nabla cogFaff$] (the value of affective component under the rate of change of the value of cognitive component) and [$\nabla affFcog$] (the value of cognitive component under the rate of change of the value of affective component). And if the difference is positive, then the direction of change of [motor] component is desirable, and if the difference is negative, then the direction of change of [motor] component is undesirable. Note that the critical difference value for direction change must also fit into the confidence level in probability statistics. To specify, (μ - critical value of difference)

If $\langle \nabla \times F \rangle motor \geq \mu$ → psycho-motor component grows ***more desirable***

If $\langle \nabla \times F \rangle motor \leq \mu$ → psycho-motor component grows less ***desirable***

Also,

If $\langle \nabla \times F \rangle cog \geq \mu$ → cognitive component grows ***more desirable***

If $\langle \nabla \times F \rangle cog \leq \mu$ → cognitive component grows less ***desirable***

Similarly,

If $\langle \nabla \times F \rangle aff \geq \mu$ → affective component grows ***more desirable***

If $\langle \nabla \times F \rangle aff \leq \mu$ → affective component grows less ***desirable***

b) Solutions to problems of the types of EFL Reticent learners

As indicated above, the relative strengths as well as the direction of changes in each of the three components shed lights on solutions to the problems of classroom instruction such as [reticence] in EFL classroom.

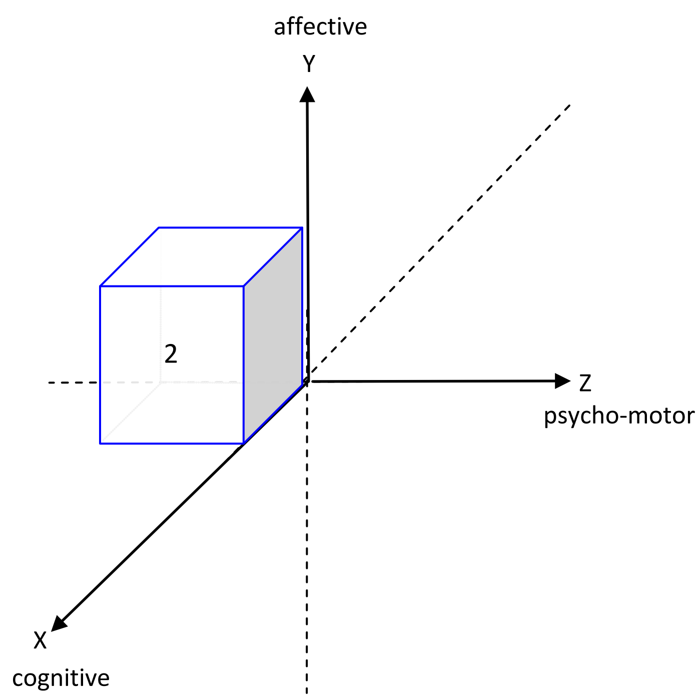

Figure 4 : The three domains on Phase 2 (where Cognitive +, Affective +, Psychomotor-]

$$\langle \nabla \times F \rangle motor = \nabla cogFaff - \nabla affFcog = \frac{\partial Faff}{\partial cog} - \frac{\partial Fcog}{\partial aff} \tag{11}$$

$$\langle \nabla \times F \rangle cog = \nabla affFmotor - \nabla motorFaff = \frac{\partial Fmotor}{\partial aff} - \frac{\partial Faff}{\partial motor} \tag{12}$$

$$\langle \nabla \times F \rangle aff = \nabla motorFcog - \nabla cogFmotor = \frac{\partial Fcog}{\partial motor} - \frac{\partial Fmotor}{\partial cog} \tag{13}$$

If instructors wish students to become more active in terms of psychomotor phase (to actively raise questions or be involved in discussion), then the dynamic among the cognitive, affective and psychomotor phases must be created as: $\langle \nabla \times F \rangle motor \geq \mu$, i.e., to enhance the changing rate of affective state over that of cognitive phase (as $\frac{\partial Faff}{\partial cog} - \frac{\partial Fcog}{\partial aff}$ indicates). To be more specific, instructors my resort to techniques arousing learners' interests, rather than giving more knowledge about the learning content.

In the same vein, in the case of Phase 4 (as indicated in Figure 5), where learners show negative sign on both cognitive and psycho-motor aspects, things become easier in that $\langle \nabla \times F \rangle motor \geq \mu$ will be more likely to exist, as $\frac{\partial Faff}{\partial cog} - \frac{\partial Fcog}{\partial aff}$ is more readily to reach $\geq \mu$. It is logical, yet worth further verification, that when learners' cognitive phase is lower than their affective phase, they are more readily to create motor responses by asking questions or be involved in group work.

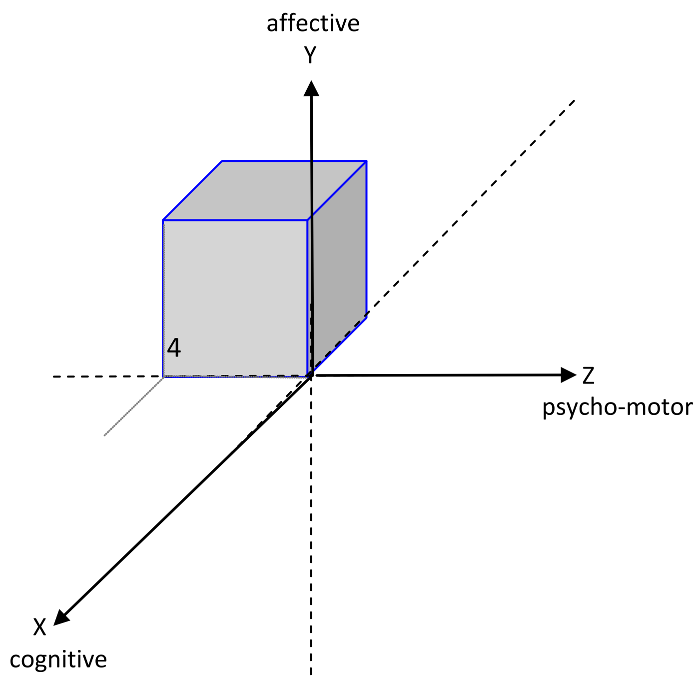

Figure 5 : The three domains on Phase 4 (where: Cognitive -, Affective +, Psychomotor -)

Next to Phase 8 (as in Figure 6), where learners show negative signs on all the phases, things become a little tricky in that to create $\langle \nabla \times F \rangle motor \geq \mu$, the changing rate (slope) of cognitive phase must be made greater than that of affective phase, (as $\frac{\partial Faff}{\partial cog} - \frac{\partial Fcog}{\partial aff}$ is more readily to reach $\geq \mu$, if $\frac{\partial Fcog}{\partial aff}$ is greater than $\frac{\partial Faff}{\partial cog}$. Again, such a situation implies that instructors may focus more on cognitive phase, to help students create motor responses.

Global Journal of Human-Social Science (G) Volume XV Issue XI Version I Year 2015

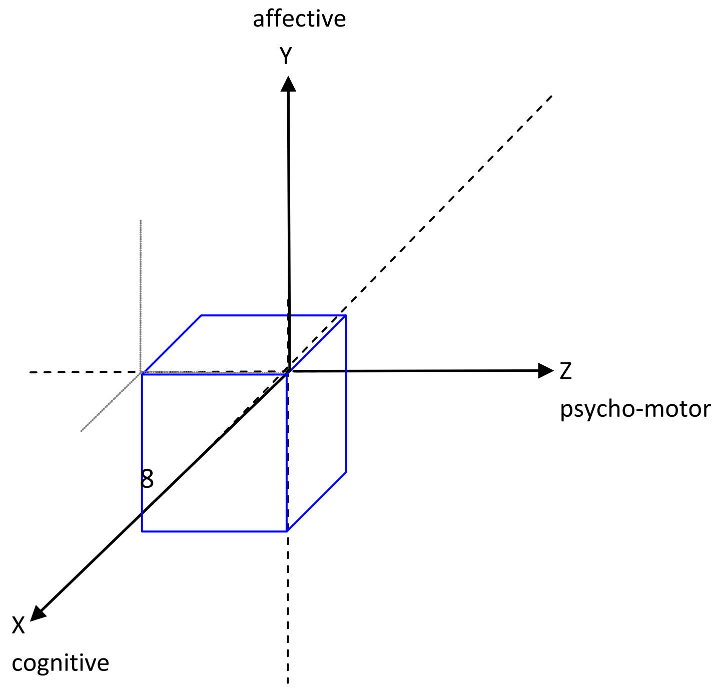

Figure 6 : The three domains on Phase 8 (where: Cognitive -, Affective -, Psychomotor -)

IV. Conclusion

Borrowing the ideas from other fields of discipline has a lot of advantages, especially when dealing with two totally different fields such as physics and psychology or even language instruction, though this may also usher a lot of disputes and criticism. In this paper, attempts have been made to integrate the laws in physics with the problems in a foreign language classroom. Undeniably, there are intrinsic differences between the laws in physics such as gradient, diversion, and curl and those found in educational psychology or instructional psychology, and direct borrowing them and mixing them may always go wrong. However, in the present paper, ideas from physics have been ruminated and checked whether they also fit into the framework of instructional psychology. Two instant benefits can be found by doing so. First, in the field of instructional psychology, the approaches adopted are often vague in terms of empirical studies, the ideas in physics based on objective calculation in the forms of equations, which clearly indicate the relationship among the variables, are more specific and objective, thus enhancing the validity and reliability of instructional relevant fields. Second, if the suggestions from the application of ideas from physics are not robust enough after further experimental verification, then at least we learn what may or may not have effect, but what if there is more insights coming from the process of integration. Innovation is required in the field of instruction. The suggestions for the solving problems of reticence in language classrooms are, in every sense, tentative, and worthy of further empirical validation.

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