Profile Shaping Education

A Paradigm Shift in Education to empower Students for Success in Modern Life

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Abstract:

Profile Shaping Education (PSE) is a novel, research-based pedagogical framework, developed under the auspices of Educational Research Center (ERC) in Lebanon. Under PSE, students develop a particular 4-P profile (Paradigmatic, Productive, Proactive, Principled) that empowers them for meaningful, rather than rote learning of course materials and success in modern life. The profile is reified in cross-disciplinary curricula in the form of well-defined learning outcomes that are defined according to a novel epistemic and cognitive taxonomy. The taxonomy focuses on common patterns in knowledge structure (epistemic outcomes) and habits of mind (cognitive outcomes) that are shared by accomplished professionals in scientific and various other educational fields. In PSE, epistemic learning outcomes cover the scope and structure of well-defined systems, and cognitive outcomes cover seven skill categories and six disposition categories. Various outcomes in any given educational field are spelled out, at any grade level, using a particular profiling schema. Students gradually develop various outcomes while systematically engaged in experiential learning cycles that are teacher mediated for efficient and insightful regulation of individual students' profiles. This paper outlines major PSE premises that are meant to bring about a paradigm shift in education to empower students for success in modern life.

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Profile Shaping Education

Profile Shaping Education (PSE) is a generic, pedagogical framework grounded in research in cognition, philosophy and history of various educational fields, sociology, and education, including research conducted by this author in collaboration with others, originally on modeling theory in science education, and subsequently at Educational Research Center, or ERC (Halloun, 2011, 2007, 2004/6, 2001). The framework sets to empower students of all levels, especially secondary school and college graduates, with a profile needed for success in modern life. The profile embodies major traits of accomplished people in the workplace and daily life, while it respects the local vision for education and local culture and heritage. It is *shaped* or reified in a given curriculum in the form of measurable learning outcomes (benchmarks, or other forms) that are determined, among others, in terms of: (a) the paradigms of the academic field(s) which the curriculum is about, (b) corroborated pedagogical principles and rules, (c) the local educational system, and (d) the current and prospective quality of teachers who will implement the curriculum (Figure 1).

This paper overviews major features of PSE as deployed in science education. It begins with an outline of the advocated 4-P profile (§ 1), and of the novel epistemic and cognitive taxonomy (§ 2) and profiling schema (§ 3) that govern profile reification in cross-disciplinary curricula. It then highlights how the profile is practically reified in PSE following a middle-out approach (§ 4) in experiential learning cycles (§ 5), through which teachers mediate insightful regulation of student profiles (§ 6), and rely on authentic assessment (§ 7). At the end (§ 8), the paper directs readers to major ERC initiatives that put PSE into practice.

1. The 4-P Profile

PSE is underlined by tenets which assert that: (a) professionals, especially those in academic communities, share common expert paradigms for knowledge construction and deployment, and (b) that there are patterns in the structure of expert paradigms and practice of accomplished professionals in various communities. PSE subsequently calls for education to systematically empower students with profiles that recapitulate such patterns.

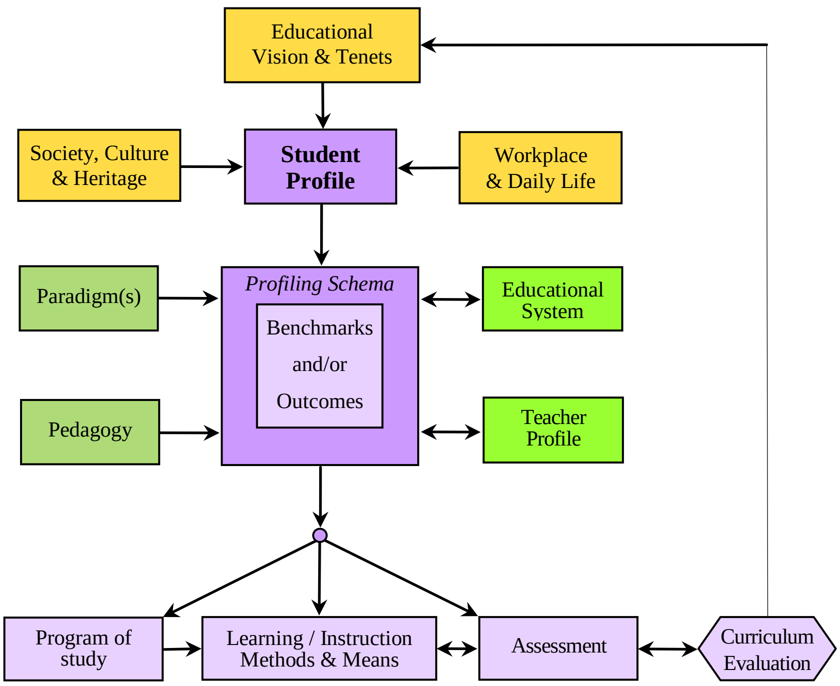

Figure 1: Profile Shaping Education (PSE) deployed in curriculum development.

An expert paradigm, i.e., a paradigm shared by accomplished members of a given profession, consists, for us, of major *tenets*, *principles* and *rules* that govern development and deployment of: (a) generic *habits of mind*, i.e., cognitive processes or skills and dispositions, and (b) coherent and efficient *episteme*, i.e., repertoires of theoretical or conceptual knowledge (concepts, laws, and other conceptions) and associated semantics and syntax (Halloun, 2004/6, 2007). As we shall see later in this paper, expert episteme in a given academic field is coherently structured around a set of conceptual systems with appropriate principles and rules for system construction and deployment.

A scientific paradigm is a paradigm accepted and shared by a community of scientists. Expert episteme in a scientific paradigm consists of a corroborated scientific theory or set of interrelated theories, with each theory structured primarily around a limited set of models. A scientific model is a conceptual system that represents a specific pattern in the real world. The pattern may be about the structure and/or the behavior of a number of physical systems in the universe. Expert habits of mind in science involve primarily modeling processes for model construction, corroboration and deployment (Halloun, 2004/6, 2007). Scientific habits of mind include generic cognitive processes (skills) and dispositions (values, attitudes, and other meta-cognitive controls) which scientists systematically invest in the construction, corroboration and deployment of scientific theory, models included.

Research shows that there are patterns in both knowledge structure and practice of accomplished professionals in the workplace. Patterns in knowledge structure are reflected in the make-up of individual expert paradigms, and, most importantly, in the way these professionals relate different paradigms within the same field and even across different fields. Patterns in practice extend from systematic paradigm construction and deployment, and insightful regulation of one's own paradigms and practice, to constructive, efficient and considerate interaction with others (Bower & Morrow, 1990; Casti, 1989; Covey, 1990; Ericsson & Charness, 1994; Gentner & Stevens , 1983; Giere, 1992, 1994; Glas, 2002; Johnson-Laird, 1983; Lakoff, 1987; Novak 1993; Viau, 1994).. Such patterns may best be reflected in the 4-P profile of Figure 2.

2. Cross-disciplinary Episteme and Cognition

The 4-P profile can be reified in a given curriculum in the form of measurable learning outcomes that may be defined in accordance with a novel PSE taxonomy. The taxonomy focuses on common patterns in knowledge structure (epistemic outcomes) and habits of mind (cognitive outcomes). These patterns are cross-disciplinary. They may be found, in one form

Paradigmatic
A paradigmatic student realizes that knowledge construction and deployment in every profession are governed by certain paradigm(s) in line with which s/he needs to develop her/his own profile. For efficient transcendence of personal paradigm(s), the student concentrates on a balanced and comprehensive repertoire of foundational and generic episteme and cross-disciplinary habits of mind that allow her/him to realize the big picture within and across disciplines.

Productive
A productive student relies on systematic ways and means, cognitive and technical, for meaningful development and constructive deployment of conceptions and habits of mind within each discipline, and for productive and creative extrapolation of conceptions and habits into other disciplines and everyday life.

Proactive
A proactive student adopts a clear vision of her/his education and future, and develops an affinity for detecting and resolving problems and for anticipating, and coping with new challenges. The student continuously seeks, and assumes control of, new learning experiences in order to evaluate and regulate her/his own profile; s/he constructively engages with others to help them do the same, and subsequently to empower self and others for lifelong learning and continuous profile development.

Principled
A principled student embraces positive dispositions, especially those that characterize her/his own culture and expert paradigms, and interacts conscientiously, respectfully and constructively with others and the environment.

Figure 2: The 4-p student profile.

or another, in various educational fields, especially in science, and can best be recapitulated in cross-disciplinary curricula that help students develop cohesive profiles rather than piecemeal knowledge about, and routines in individual fields. Such cross-disciplinarity is ensured in PSE through common epistemic and cognitive taxonomy for all educational fields, science included. Epistemic learning outcomes cover the scope and structure of well-defined systems, and cognitive outcomes cover generic habits of mind (reasoning skills and dispositions). PSE calls for students to gradually develop various outcomes in four stages while systematically engaged in a variety of experiential learning activities (Halloun, 2007, 2011).

Epistemic taxonomy in PSE is about the scope and structure of a limited number of *systems* (conceptual models, in science) that best reflect specific patterns in content knowledge in a given educational field, and that offer students the best context for meaningful construction of various conceptions (concepts, laws, and other theoretical statements). The *scope* specifies the *domain* of a system (what pattern the system represents in either the physical world or conceptual realm) and its *function* (what the system is good for, and under what conditions). The *structure* dimension specifies the *composition* of the system (what primary entities the system consists of, and what are their salient properties), its *internal structure* (how these elements and their properties are related to each other within the system), and its *external structure* (how the system relates to its environment and/or other systems within and outside the confinement of its paradigm).

Cognitive taxonomy in PSE covers seven categories of skills and six categories of dispositions. Skill categories include analysis, criterial reasoning, relational reasoning, critical reasoning, logical reasoning, technical dexterity and communication dexterity, while disposition categories include affects, attitudes, morals, ethics, values and beliefs that govern, from a meta-cognitive perspective, the development of episteme and skills (Table 1).

There is no particular developmental hierarchy within the epistemic, and especially the cognitive taxonomy. There is no particular order in which a student develops the scope and structure of a system, or various reasoning skills and dispositions. However, a certain hierarchy may be identified within each epistemic or cognitive dimension that depends on the variation of complexity of, and cognitive demands imposed by, a given dimension in a system or a given reasoning skill or disposition. For example, within the category of analysis, we may distinguish between exploratory analysis and inferential analysis (Table 1). Exploratory analysis is about describing or explaining a particular state of a given system, as it exists at given point of space and time. Inferential analysis is about making inferences about the system in question beyond that particular state, e.g., predicting how the system may evolve in the future under certain conditions, or post-dicting how the system evolved in the past before it got to the state in question. One can readily realize that inferential analysis comes at a higher cognitive level than exploratory analysis, and that explanatory analysis (identifying salient causes of the conservation or change of state of a system) comes at a higher level than descriptive analysis (identifying primary features of a given state).

According to PSE, students develop any conception, reasoning skill or disposition gradually and not in a single instance, and in conjunction with other conceptions and habits of mind and not individually. Any person may progressively “know” (or “learn” about) a given system, and develop and deploy any conception or habit of mind, in four consecutive stages. These are in order: Initiation or primitive learning, gestation or rote learning, replication or reproductive learning, and innovation or productive learning. Meaningful learning begins in the third stage, and culminates in the fourth stage. Furthermore, meaningful learning involves a conscious interplay between various conceptions and habits of mind that may take place when students are engaged, individually or together, in three types of learning settings which we term core-engagement, eco-engagement, and meta-engagement.

The four stages may be outlined as follows in the development of a given system:

Table 1

Cognitive Taxonomy

Reasoning Skills						
Analysis	Criterial reasoning	Relational reasoning	Critical reasoning	Logical reasoning	Communication dexterity	Technical dexterity
• Exploratory analysis (descriptive, explanatory, causal) • Inferential analysis (predictive, controlled change) • Differential analysis (distinguish between primary and secondary aspects) • • •	• Comparison • Contrast • Classification • Pattern recognition • Analogical reasoning • Estimation • Measurement • Setting criteria for objective reasoning • • •	• Syntactical (internal) connections • Bridging/ External connections • Correlation • Functional relation • Synthesis • Extrapolation • Transfer • Setting model structure • • •	• Reflective thinking • Evaluation of evidence and claims • Corroboration of claims and hypotheses • Questioning "facts" • Question formulation • Problem detection & formulation • Challenge anticipation • SWOT evaluation • Situation control/change • Innovation • • •	• Evidence-based argument • Justification • Proof • Hypothesis formulation • Assumptions making • Conjecturing • Decision making • Solution design and deployment • Adduction • Induction • Deduction • Generalization • Metaphorical reasoning • Esthetical reasoning • • •	• Verbal expression • Symbolic expression • Graphic expression • Kinesthetic • Semantic interpretation • Coordination of various depictions • Sense making • Eloquence • Accuracy • Precision • Concision • Clarity • • •	• Conventional technology operation rules • ICT equipment operation rules • Network search • Web interaction • e-learning • e-assessment • • •

Dispositions					
Affects (Self)	Attitudes (Others)	Morals	Ethics	Values	Beliefs
• Intrinsic locus of control • Confidence • Self-awareness • Impulsivity control • Perseverance • Commitment • Affinity for auto-regulation • Curiosity • Imagination • Creativity • Striving for excellence • Efficiency • • •	• Open-mindedness • Inter-dependence • Tolerance • Empathy • Flexibility • Objectivity • Skepticism • Construc-tiveness • Humor • Synergy • Dedication • Calculated risk taking • • •	• Honesty • Honor • Integrity • Fairness • • •	• Ethics of the discipline • Regulation abiding • Equity • Justice • Precision • Upholding accuracy • No cheating • • •	• Respect of others' rights • Respect and fostering of own heritage and culture Respect and appreciation of: • Diversity • Freedom • Order • Cleanliness • • •	• No unsustainable beliefs • Differentiation between belief and knowledge • Evidence-based conviction • Belief in own ability to make a difference • • •

1. *Initiation* (*primitive learning*), when a learner is simply aware that the system exists, but knows nothing or a little about its scope and structure, and is still incapable of successfully deploying related conceptions and necessary habits of mind in any situation.
2. *Gestation* (*rote learning*), when the learner develops partial knowledge about the scope and structure of the system, and is capable of deploying certain related conceptions and necessary habits of mind, exclusively in the context of the system in question when encountered in familiar situations.
3. *Replication* (*reproductive learning*), when the learner develops satisfactory knowledge about the scope and structure of the system, and is capable of deploying related conceptions and necessary habits of mind, exclusively in the context of the system in question when encountered in familiar situations and new, but mostly similar, situations.
4. *Innovation* (*productive learning*), when the learner develops comprehensive knowledge about the scope and structure of the system, and is capable of creatively deploying this knowledge, especially corresponding habits of mind, within the context of the same and other systems encountered in totally novel, unfamiliar situations.

Various elements of the epistemic or cognitive taxonomy are gradually developed and deployed, not individually but together in various combinations, and in one of the following three settings:

Core-engagement, which brings about systems, processes and dispositions in the purpose of looking at the big picture within a given field, and designing and carrying out appropriate plans for systemic and system-based thinking (modeling included), problem solving and experimenting with, and regulating (controlling or changing) existing situations in that field. Ultimately, one will bring about creative and innovative ideas and products about the field, at school or in the workplace, as well as in everyday life.

Eco-engagement, which includes self-management as well as interaction with others, especially peers (teamwork included), and the environment, decision making, and crisis management.

Meta-engagement, which includes auditory, visual, and/or kinesthetic assimilation and adaptation of conceptions, and various conscious actions for the development of habits of mind, as well as various meta-cognitive controls that govern lifelong learning and, especially, learning how to learn inside and outside the classroom.

3. Profiling Schema

The *profiling schema* is a generic tool that can be used for spelling out, together or separately, epistemic and cognitive outcomes associated with any system; outcomes which research shows to be comprehensive, from both paradigmatic and pedagogic perspectives, and critical for students at any level to meaningfully understand the system. Figure 3 shows the profiling schema in the form of a template that may be gradually deployed to set the epistemic and cognitive outcomes associated with any model in science. The schema may similarly be deployed with any other system or conception in science or any other educational field.

Conceptions and habits of mind may first be stated in general terms (benchmarks) for a given system. As such, the schema serves as a “broad profiling schema”, or “benchmark schema”. Subsequently, or concurrently, conceptions and habits of mind may be translated into measurable learning outcomes that are suitable for the target population of students. The schema then serves as “outcome schema” (Halloun, 2001, 2007, 2011).

System: Bohr's Atomic Model		**Conceptions**	**Habits of Mind**
Scope	**Domain**	Hydrogen atom and hydrogen-like (or hydrogenic) ions.	Criterial reasoning and differential analysis whereby: (a) a pattern is defined among hydrogenic atom/ions that may be classified together and distinguished from many-electrons atoms or ions, and (b) the appropriate theory is chosen to construct and deploy the Bohr model (e.g., the classical theory governing the so-called standard model).
	Function	Description and explanation of certain, but not other, aspects of a single electron bound on a circular orbit.	Logical and critical reasoning by virtue of which particular questions are specified that the Bohr model may answer, to certain limits, about hydrogenic atom/ions, in the context of the chosen theory. Exploratory analysis to set what the model can specifically describe and explain about hydrogenic atom/ions.
Structure	**Composition**	A nucleus with one (hydrogen) proton or more (hydrogenic ions), and a single electron. Properties of interest include mass and charge of these entities, and state properties of the electron (e.g. velocity).	Differential analysis by means of which specific (primary) entities (electron and nucleus) and object and state properties are exclusively included in the model, and other (secondary) entities and properties are left out.
	Internal Structure	Interaction between the nucleus and the electron partially represented by a central (binding) Coulomb force exerted by the proton(s) in the nucleus on the electron.	Criterial reasoning to establish either structure, say in the context of classical theory, by analogy to planetary models (e.g., Earth-Moon system in the solar system). Relational reasoning to establish relations between primary properties of various entities in the form of state, interaction and causal laws; and representation dexterity to express those laws algebraically, graphically…
	External Structure	Interaction between the atom in question and other neighboring atoms (molecular structure), or other types of environment (e.g., electromagnetic field).	

Figure 3: Sample benchmarks associated with Bohr's atomic model in physical sciences.

Figure 3 illustrates the use of the schema as a benchmark schema for Bohr's model of the atom. Each cell in the benchmark schema is partially filled with a sample of, but not all, conceptions or habits of mind that are typically covered at the secondary school or college level (Figure 3). The reader can easily realize that *epistemic* cells under "conceptions" include particular information or theoretical statements about the scope or structure of the model that are commonly accepted by the concerned community of professionals (scientists), and that the student is expected to "*have*" at a given point of instruction. In contrast, the reader can readily realize that *cognitive* cells under "habits of mind" include what the student is expected to "*be*" capable of doing at that stage, and this in the form of habits of mind, i.e., processes or dispositions, which the student is expected to develop in the context of a given system, but which are of generic nature, i.e., which the student can deploy in the context of any other system.

4. Middle-out Structure and Processes

Conceptual systems are at the center of what we call *middle-out* epistemic and cognitive structure of expert paradigms in any academic field. Conceptual systems, and particularly models in science, are in the "middle" of conceptual hierarchy, between theory and concept. A scientific model is to theory and concept what an atom is to matter and elementary particles. Each elementary particle is essential in the structure of matter, but its importance cannot be conceived independently of its interaction with other particles inside an atom. It's the atom and not elementary particles that give us a coherent and meaningful picture of matter, and it's the atom that displays best the role of each elementary particle in matter structure. As such, conceptual systems, and particularly models in science: (a) ensure a cohesive structure of expert (scientific) theory, and (b) constitute the most accessible, efficient and reliable building blocks in knowledge construction and deployment. Conceptual systems subsequently ensure expert theory and paradigm coherence and consistency from an epistemic perspective, and they facilitate development of expert knowledge from a cognitive perspective (Halloun, 2004/6, 2007; Lakoff, 1987).

PSE calls for the development of any course, and especially in science, in a middle-out approach from both epistemic and cognitive perspectives. Accordingly, (a) all target conceptions at any level are supposed to be developed as building blocks of corresponding systems (models), and not as self-contained entities, and (b) all target habits of mind are meant to be developed in the process, beginning with subsidiary systems. A *subsidiary system* is a simplified version of a target expert system, a particular case which students may usually be most familiar with, and which can serve as a stepping-stone for the comprehensive construction of the target system.

For example, a particle in free fall (objects falling in vacuum in the absence of any force except for gravity) may serve as a subsidiary model of the uniformly accelerated particle model in Newtonian theory (Halloun, 2007). To construct the latter model, students may begin resolving any incommensurability between their own ideas about free fall and the Newtonian perspective on this type of translation (replication stage in Section 2). They would then gradually develop this subsidiary model restricted to the case of linear motion in a constant gravitational field, and extrapolate it into the broader case of parabolic, uniformly accelerated motion under any type of a net constant force (or field). The subsidiary model in question would thus serve, at the lower end of the middle-out hierarchy, to develop or refine conceptions and habits of mind required for the particular instance of free fall, and, at the upper end, to extrapolate the subsidiary model into the construction of the target uniformly accelerated particle model. Meanwhile, habits of mind developed, and/or refined, in the context of the subsidiary model, would be gradually de-contextualized in the process, so that students may subsequently deploy them into more complex situations within and outside the context of the course in which they are enrolled (thus reaching the innovation stage).

5. Experiential Learning Cycles

Under PSE, students are constantly engaged in a variety of experiential, i.e., hands-on, minds-on learning activities that help them develop expert episteme meaningfully, and expert habits of mind productively. All activities are conducted within well-structured, 4-phase learning cycles (exploration, adduction, formulation, deployment), each cycle being devoted primarily for the construction of a particular conceptual system.

In science, a PSE learning cycle is a modeling cycle, a cycle for model construction and deployment. Each cycle begins with an *exploration* phase whereby students discover the potentials and limitations of models (or specific other conceptions) they have developed so far, and realize the need to construct a new model that represents a specific pattern. Students are then directed, in the *adduction* phase, to propose appropriate hypotheses about the desired pattern, i.e., to propose a candidate model, and an appropriate strategy for testing their hypotheses. The strategy, subsequently implemented in the *formulation* phase, would take students into a process of gradual corroboration and progressive refinement of the proposed model. At certain points during the process and afterwards (*deployment* phase), students deploy the model in order to consolidate it and relate it to other models within the context of the theory which all these models belong to (Halloun, 2001, 2004/6, 2007).

A PSE learning cycle is typically structured around the profiling schema of Figure 3. Throughout a given cycle, students are guided to gradually develop the epistemic and cognitive learning outcomes set in the schema. Gradual development of any given outcome follows the 4 stages outlined in Section 2 of this paper, and this in a variety of settings that allow for core-, eco-, and meta-engagement of individual and group of students (Section 2 above).

6. Mediated Insightful Regulation

PSE instruction is student-centered, teacher-mediated. It is student-centered in the sense that it engages individual students actively in the learning process, but it does not leave them out entirely on their own free will. Any course has a specific agenda to fulfill: meaningful and insightful evolution toward the target 4-P profile. This agenda cannot be fulfilled without teacher mediation that prevents students from going astray and wandering in futile paths, and that structures their experiential learning activities for the gradual development of the target profile (Halloun, 2004/6, 2007; Kirschner, Sweller & Clark, 2006).

Teacher mediation is meant to constantly induce students to reflect back on whatever episteme or habit of mind that they might already possess, and that relate to what they are learning in the classroom. Such reflection is made *insightful* in the sense that individual students become consciously aware of the limitations of their own conceptions and habits of mind (including their learning styles), and of the sources of error when committed, and they explicitly realize what makes expert paradigms superior from all perspectives. The reflection is also *regulatory* in the sense that individual students resolve any incommensurability between their own paradigms and expert paradigms, and they progressively proceed in the direction of achieving the 4-P profile.

Rules of engagement in science education may somewhat recapitulate the historic development of scientific paradigms. Educational research has systematically shown in the last three decades that science students are encumbered with naïve paradigms that are often reminiscent of pre-Galilean paradigms. Teachers are subsequently encouraged to turn to the history of science in order to better understand the foundations of student paradigms and identify historical cases that may be deployed in educational settings for regulating students' knowledge and resolving incommensurability between student paradigms and scientific paradigms. In this respect, student regulation may be directed in ways that recapitulate the history of science, especially at critical turning points whereby Galileo and his successors relied on systematic modeling of physical patterns to overcome the limitations of naïve thinking and take science into major paradigmatic shifts. In fact, under PSE science instruction, student realism is often successfully regulated to reach certain level of commensurability with scientific realism, by guiding students through processes similar to those of successive refinements of model-laden theory and inquiry which Galileo and his successors went through (Halloun, 2007).

7. Authentic Assessment

Teacher mediation in PSE is guided by authentic assessment which allows teacher and students to reliably: (a) ascertain the extent to which individual students meaningfully achieve epistemic and cognitive learning outcomes at specific points of instruction, (b) identify progress or evolution paths of individual students' profiles throughout the course of instruction, (c) track and efficiently regulate the evolution of student profile along these paths in meaningful ways, and (d) evaluate and efficiently regulate course content and teacher practice, and subsequently the curriculum. In short, authentic assessment is meant to be assessment *for* learning and *not of* learning.

Under PSE, teachers rely on the profiling schema of Figure 3 for designing various types and forms of assessment tools, as much as they rely on it for planning and carrying out instruction. Tracking and regulating the evolution of individual students' profiles being the major objective of assessment, teachers design and deploy their tools in order to determine the stage reached by a given student in the 4-stage hierarchy outlined in Section 2, and subsequently prescribe the appropriate remedial or reinforcement learning activities. In the process, teachers pay special attention to certain critical thresholds.

A number of *thresholds* may be defined within any course that set: (a) a paradigmatic hierarchy in the structure of the course, and especially (b) an efficient cognitive and pedagogical sequence in the scope of the course. The most critical of these thresholds are the “basic threshold” and the “mastery threshold” (Figure 4). The basic threshold is set between the *core* body of knowledge and the *fundamental* body of knowledge.

In science courses, core knowledge corresponds to a limited number of the most *basic models* in the context of which, from a pedagogical perspective, can be developed the most fundamental and critical conceptions and habits of mind of the scientific theory which the course is about. Fundamental knowledge embodies somewhat more complex *basic models* in the context of which students reinforce, and widen the scope of, core conceptions and habits, and derive from them new conceptions and habits. Emergent knowledge typically involves models that may emerge from the composition of two or more basic models, as well as original, more complex models (Halloun, 2007, 2011).

A student needs to meaningfully develop the *entire* core knowledge before s/he can proceed to fundamental knowledge. Any flaw in developing any conception or habit of mind in the core knowledge prevents the student from crossing the basic threshold, and thus from developing fundamental knowledge meaningfully. Students normally require significant teacher mediation in order to reach such threshold. Once they cross it, teacher mediation can be gradually reduced throughout the fundamental body of knowledge until students cross the mastery threshold. Beyond that threshold, students should be capable of developing the more complex emergent knowledge with the least teacher mediation ever. In relation to the stages of Section 2, the basic threshold somewhat corresponds to the third stage of replication, whereas the mastery threshold corresponds to the fourth stage of innovation.

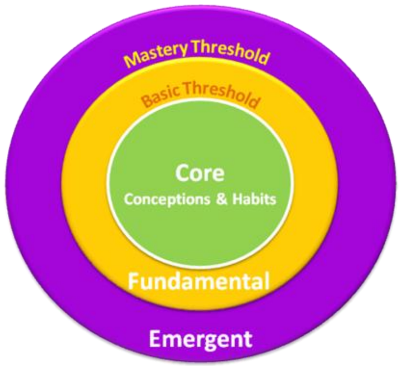

Figure 4: Critical thresholds in a given course set from paradigmatic and pedagogic perspectives.

8. PSE Initiatives

PSE is deployed in a number of projects at Educational Research Center (ERC), including two major pan-Arab initiatives, the International Arab Baccalaureate (IAB), and a teacher education program that has just been launched for continuous professional development of in-service teachers. IAB is a school-based program that promotes the development of the 4-P profile of Figure 2. It relies on an electronic platform for authentic assessment that allows continuous monitoring of individual students’ profiles and of various authentic assessment items accessible through the platform. The platform is gradually evolving into an e-learning platform that would be used for blended learning in both IAB and the teacher education program. Ample details about these and other PSE initiatives are beyond the scope of this paper, and can be found at www.EducationalRC.org.

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