Systemism: *a synopsis**

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We live in a rapidly changing world that requires us to readily and efficiently adapt ourselves to constantly emerging new demands and challenges in various aspects of life, and often bring ourselves up to speed in totally novel directions. This is especially true in the job market. New jobs with totally new requirements keep popping up, and some statistics forecast that, by 2030 or so, about two third of the jobs would be never heard of before. Increasingly many firms suddenly find themselves in need of restructuring or reconsidering their operations or even the very reason for which they existed in the first place, which may lead to the need of their employees to virtually reinvent themselves.

Our times require us, at the individual and collective levels, to have a deeply rooted, futuristic mindset. On the one hand, such a mindset would preserve and build upon the qualities of the past, and respects the order of the universe, mother nature, and human beings and societies. On the other hand, it would make us critically and constructively ride the tracks of the digital era, and insightfully take those tracks into humanly and ecologically sound directions. A systemic mindset can best meet these ends.

A *systemic* mindset stems from systemism, the worldview that the universe consists of *systems*, in its integrity and its parts, from the atomic scale to the astronomical scale, from unicellular organisms to the most complex species, humans included, and from the physical world of perceptible matter to the conceptual realm of our human mind. Systemism offers us the best framework to systematize and infuse order in our everlasting quest to make sense of the world around us and develop and deploy our knowledge about this world in meaningful and productive ways. It also helps us optimize our engagement with others, and bring about processes and products that none of us can produce on her/his own independently from others.

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* This synopsis consists mostly of excerpts from the following publications:

Halloun, I. (2019). Cognition and Education: A Bungean Systemic Perspective. In: M. R. Matthews (Ed.), *Mario Bunge: A Centenary Festschrift*, pp. 683–714. Boston, MA: Springer.

Halloun, I. (2018). *Systemic convergence in education: A synopsis*. Working paper. Jounieh, LB: H Institute.

Halloun, I. (2018). *Scientific models and modeling in the framework of Systemic Cognition and Education*. Jounieh, LB: H Institute.

Halloun, I. (2018). *SCE Taxonomy of Learning Outcomes*. Working paper. Jounieh, LB: H Institute.

Halloun, I. (2017). *Mind, Brain, and Education: A systemic perspective*. Working paper. Jounieh, LB: H Institute.

Halloun, I. (2011). From modeling schemata to the profiling schema: Modeling across the curricula for Profile Shaping Education. In: Khine & Saleh (Eds), *Models and Modeling in Science Education*, vol. 6, pp. 77–96. Boston, MA: Springer.

Halloun, I. (20004/2006). *Modeling Theory in Science Education.* Dordrecht, NL: Kluwer Academic Publishers / Boston, MA: Springer.

These publications and more are available at:
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1. Systems

A system has been defined in a variety of ways in the literature, but definitions converge on that a system may consist of one entity (if simple) or many interacting or connected entities (if compound) confined within well-defined boundaries to serve particular purposes. The constituent entities, and thus the system, may be either physical, if consisting of material objects, or conceptual, if consisting of abstract elements (e.g., scientific models).

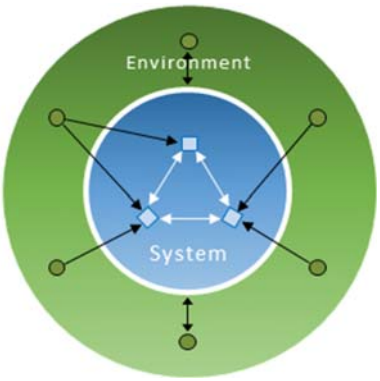

Figure 1. System delineation

The boundaries of a system are usually delineated by convenience, especially in terms of the purposes or function it is meant to serve, and so are chosen various elements and connections of interest within and outside the system boundaries (Fig. 1). The boundaries of a system and its environment (surroundings or settings in which it is embedded) are primarily determined by the purpose(s) the system is supposed to serve. The boundaries may then be conveniently delineated to account for certain entities and/or interactions (or connections) among entities of primary interest, and not others, in order to optimize what we are trying to achieve with the system. Sometimes, these boundaries are delineated so that the system consists of a single entity with no internal interaction/ connections, and at other times, to embody all entities of interest inside the system and end up with an isolated system with no environment to interact with. At all times, we are interested in specific interactions but not others within the system or with its environment. The arrows in the figure depict three such instances.

The two-sided arrows between system *constituents* (entities inside the system depicted with squares in Figure 1) indicate an interest in *mutual inter*actions or relationships between connected entities. The one-sided arrows between certain *agents* in the environment (entities outside the system depicted with disks) and constituents of the system indicate an interest only in the *action of* those agents on designated constituents, but not in the reciprocal action of constituents on agents (sometimes called reaction). The two-sided arrows between the system boundaries and agents in the environment indicate an interest in certain *mutual inter*actions between connected agents and the system as a *whole,* thus in the synergetic impact on the environment of all elements in the system acting together, and not the impact of individual system constituents.

2. System schema

We define a system of any sort, in both the physical world and the conceptual realm of human knowledge, in accordance with a four-dimensional schema that specifies the system's scope, constitution, and performance in the context of an appropriate framework (Fig. 2).

1. The *framework* of a system consists of all: (a) theoretical premises, like assumptions, principles, value system, and other ontological, epistemological, methodological, and axiological maxims and provisions typically spelled out in the paradigm of a professional community, and (b) ensuing strategic choices, which, along with theoretical premises, guide the specification and reification of the scope, constitution, and performance of a system.

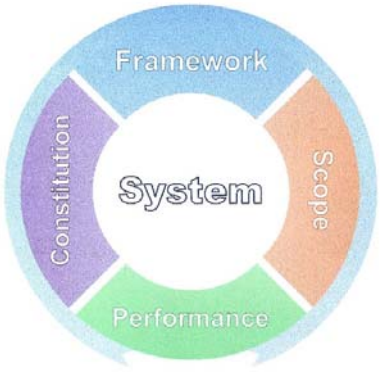

Figure 2. System schema.

2. The *scope* of the system specifies:
    a. the system *domain*, or the field or area in which it exists and is of importance;
    b. the system *function*, or the specific purposes it is meant to serve in that domain.
3. The *constitution* of the system specifies:
    a. the system *composition*, i.e., its primary or pertinent constituents that may be physical or conceptual entities (objects and their primary individual properties) inside the system, and that are relevant to its function, as opposed to secondary entities that may actually be part of the system but that may be ignored because we deem them irrelevant to the system function;
    b. the system *structure*, i.e., primary connections (interactions or relationships) among primary constituents that determine how the system serves its function;
    c. the system *environment*, i.e., its primary agents or primary physical or conceptual entities outside the system, other systems included, along with their primary individual properties, that may significantly affect the system structure and function, and that may be separated into two clusters, *local* in the immediate vicinity, and *global* in relatively distant or remote areas (Fig. 3);
    d. the system *ecology*, i.e., primary connections (interactions or relationships) between individual primary agents and constituents, and/or between the system as a whole and its environment, that significantly affect how the system serves its function and affects the environment.

Figure 3. System & environment.

It is worth stressing here that the composition and environment facets of the constitution dimension only list system constituents and agents, and do not establish connections among them. Such connections are the object of the structure and ecology facets.

4. The *performance* of the system specifies:
    a. the system *processes*, i.e., dynamical actions (operations, mechanisms, or maneuvers) which constituents, and/or the system as a whole, might be engaged in, on their own (isolated system) and/or under external influence (of the environment), in order to serve the function of the system following specific rules of engagement;
    b. the system *output*, i.e., products, events, or any other effect (services included, when the system is, say, of social or industrial nature) that the system actually brings about, on its own or in concert with other systems as a consequence of its ecological interactions and processes, and that may fall within or beyond the scope originally set for the system.

Tables 1 and 2 at the end of this paper illustrate the use of the system schema to define systems of any sort. Table 1 outlines a physical system consisting of our planet Earth in a Sun and Moon environment for the purpose of describing and explaining particular natural phenomena on Earth. Table 2 outlines a social system consisting of any school the purpose of which is to empower students with profiles for success and excellence in modern life, not for merely passing traditional school and high stakes exams. Each of the two examples provides a partial sketch of what a system may consist of for serving specific purposes. Each system is delimited as discussed in section 1 (Fig. 1) to serve the indicated purposes. System boundaries and environment can always be redefined in terms of the purposes a system is meant to serve.

3. Some advantages of systemism

Systemism comes with many advantages for us, humans, in our conceptual realm and practical life. In both worlds, systems infuse order and bring along characteristic features, like wholeness and holism, that would not have been possible, or at least not as significant, without such coherent and efficient formations. In the conceptual realm, systems resonate perfectly well with the way our human brain is and operates. In practical life, and particularly in education and industry, various academic and technical fields lend themselves to convergence readily and optimally when conceived and deployed in the form of systems.

3.a Wholeness and holism

According to Poincaré (1902)*, things gain their significance from realist and rational perspectives only when related to each other. An entity, whether physical or conceptual, has little significance, if existing in isolation from other entities. The entity gains significance when it interacts with other entities, or when it is related, or connected to such entities in a well-defined structure. For instance, a heap of stones has little importance and utility. To borrow Bunge's words (1979, p. 3)*, the heap is an "*aggregate* or assemblage ... a collection of items not held together by bonds, and [it] therefore lacks integrity or unity". Stones become far more important when used in constructing a wall, and even better, a house. It is how the stones are stacked, how they are connected to each other, that turns the heap into a significant and useful structure, say a dwelling system.

A systemic perspective of the world allows us to bring cohesion and coherence to this world, as well as to our own thinking, and to understand certain aspects of this world that may not be easily conceived – and perhaps that may not be conceived at all – without such perspective. Such is the case, for example, with wholeness and holism. *Wholeness* is, for us, about the impact of any given entity or interaction (or connection of any sort) in a system on the entire system. Every constituent of the system interacts with (or is related/connected to) other constituents and somehow affects the state of the entire system. A change in any given constituent or in any given interaction or relationship between two constituents may result in a change of the entire system. Such a global impact can best be conceived and explained in the context of a system as a whole and not in terms of any clusters of relationships. *Holism* is, for us, about the added value that a system as a whole brings to its constituents and the surrounding environment. A system is *holistic* in the sense that, as a *whole*, it is more than the sum of its parts. It has *emergent properties* (e.g., the shape of a house) and *synergetic functions* (e.g., dwelling) that no constituent (e.g., a stone) possessed individually before. The two holistic features may not be attributed to its individual parts and may not be fully understood and appreciated by simply breaking the system into such parts (by analysis or following a reductionist approach).

A caveat is quickly due at this point. Wholeness and holism, as we see them, do not deny the importance of individual constituents of a system within and outside the context of the system. The two systemic features do not necessarily imply a certain determinism or irreversibility in the state of system and constituents, especially not when of human or social nature. Under propitious conditions, a system may change its evolution course, and may as well recover from certain induced changes and return to its original state.

3.b Systemic cognition

We are constantly engaged in cognitive development, i.e., in the development of our content and process knowledge, and thus in changing the state of our mind (and brain) in certain

respects, whether consciously or not, and purposefully or not, and whether or not we are interacting with the outside world. A cognitive experience, or learning experience, is always a *transaction* between a learner and an object of learning (among other things), whether the object is physical or conceptual. The transaction results in an emergent knowledge that cannot be attributed directly to either learner or object of learning alone, and that cannot be conceived as the mere sum of learner and object features. The emergent knowledge can best be constructed, understood, and taken advantage of when the transaction is conceived in a systemic perspective.

Among other distinguishing features, a systemic transaction allows *patterns* to be readily revealed in both the external world and the intrinsic conceptual realm of a given learner, and especially of a community of learners. Patterns, like day and night cycles and grammatical rules in a given language, are common regularities in space and time in the structure or behavior of different physical or conceptual entities. Patterns predominate and repeat themselves in the universe at all levels, from the subatomic scale to the galactic scale, including the human mind, brain, and body, and that makes our world interesting and comprehensible.

Patterns predominate in our thoughts and memories, and we have a natural tendency to look for patterns in the world around us, and even to rationally impose patterns on what we perceive in this world or conceive about it. Our long-term memories consists of nothing but patterns. No new knowledge can be sustained in such a memory unless it is a pattern or part of a pattern that can be readily embedded with patterns already in store. Systemic transactions allow us to efficiently identify patterns of interest in the physical world as well as the conceptual realm of individuals and groups of people, to rationally conceive of those patterns, and to efficiently integrate corresponding knowledge in our memories.

3.c Cognitive and practical convergence

Numerous efforts have been deployed lately for *convergence* of research in different academic fields and operations in industry and various other sectors of society, i.e., for removing boundaries between distinct academic and technical fields in all domains, and carrying out processes, including knowledge development and problem solving, in coherent if not similar ways. Convergence is meant to facilitate and improve the efficiency of communication, knowledge exchange, and collaboration among various professionals on issues of mutual interest, especially in those fields that were traditionally considered as remotely related, if any, like arts and sciences.

In academia, convergence is primarily about bringing together many academic fields to come out with certain products that may extend from the solution to a particular type of abstract or real world problems to a full-fledge new field (Fig. 4). Convergence usually involves not entire fields, but certain disciplines from different fields (e.g. classical mechanics and relativity in physics, algebra and calculus in mathematics).

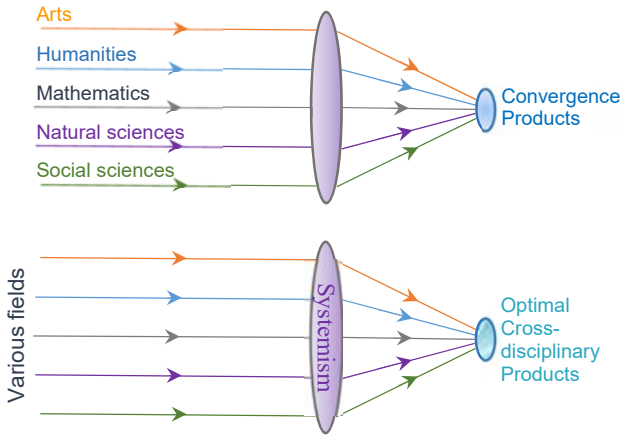

Figure 4. Convergence among many academic fields to bring about products of particular structure and function (Top). Convergence is optimized when carried out through systemic lenses to bring about cross-disciplinary products (Bottom).

Cross-disciplinarity results from the integrative convergence of two or more disciplines, mostly from different fields, academic or not, related to different sectors of society. Professionals from different disciplines/fields work collaboratively together to develop cross-disciplinary products needed within and/or outside their own professional communities, and deploy to this end a mix of already established and novel efforts. Unlike other forms of disciplinary convergence, under cross-disciplinarity, various professionals bring together, to common facilities, their distinctive conceptual and procedural knowledge, tools, resources, etc., under an *emergent* paradigm that draws on common and concurrent aspects of their distinctive paradigms and incorporates newly agreed upon aspects. The new paradigm may sometimes *transcend* all existing paradigms and lead to the development of a brand new discipline that cuts across existing fields or that lays the ground for a completely new field. The emergent/transcendent paradigm opens the door to tackling in creative or even *innovative* ways old and new questions, problems, or issues. Crossdisciplinary products may have a mix of new and already known characteristics or entirely new characteristics.

Cross-disciplinarity (XDP) is nowadays especially important in education for many reasons including the following:

1. XDP allows for all sorts of innovative collaboration among diverse fields in various public and private sectors of society. Such collaboration is nowadays badly needed in education to ensure sustainable educational systems and curricula that effectively meet the actual needs of individual growth and community development in the current century.
2. XDP provides for coming up with totally novel educational systems and curricula that transcend existing traditional general and technical and vocational establishments and disciplines. Such transcendence is urgently needed in our times as traditional systems and curricula can no longer empower our students to meet the needs and overcome the challenges of the workplace and various aspects of our daily life.
3. XDP is optimal for educational systems and curricula to be flexible and dynamic enough to provide for empowering students for lifelong learning and to be continuously revised to meet the continuously changing requirements for induction and success in the workplace and every other aspect of modern life.
4. XDP lends itself better than all other convergence modalities to innovative converging lenses (Fig. 4) especially systemic lenses that allow us to accomplish all the above and more in the most meaningful, productive, and efficient ways possible (as implied by long years of educational research and practice, ours included).

Table 1

Partial outline of a physical system (Earth under Sun and Moon influence) in accordance with the system schema

Systemic dimension / facet		Sample benchmarks for Earth under Sun and Moon influence
Framework		Classical planetary theory stemming primarily from the works of Kepler and Newton.
Scope	**Domain**	The system partially outlined here refers to: • Our planet Earth as part of our Solar system. • All possibly similar planets in the Universe.
	Function	Description and explanation of many phenomena, including (for illustration purpose) but not limited to: • Day and night. • Seasons. • Tides.
Constitution	**Composition**	For describing and explaining the three phenomena above: • Earth can be considered, to a very good approximation, a "simple" spherical object the physical constituents of which may be ignored. • Primary (i.e., necessary or relevant) properties include Earth mass (if gravitational forces need to be studied), its quasi-spherical shape, its axis of rotation, and its position at specific times relative to the Moon and Sun.
	Structure	• The internal structure (relations among its physical constituents) of Earth can be ignored when studying the considered phenomena. • In 2019, the Earth's axis of rotation is tilted at an angle of about 23° 26' with respect to the normal to the plane of its elliptical orbit around the Sun (see the Processes facet). • The tilt angle of the Earth's axis of rotation constantly changes, though slightly, throughout the years.
	Environment	• The primary agents of Earth (objects in its local environment that are relevant to and affect the phenomena of interest) that need to be considered are: the Sun for the first two phenomena (day and night, seasons), and the Moon for the tides phenomenon. • Aside from their position relative to Earth, and only if gravitational forces need to be evaluated, the mass of each agent is the only intrinsic primary property to take into consideration.
	Ecology	• For the three considered phenomena, we only need to consider the actions on Earth of its agents, the Sun and the Moon, and not the reciprocal action of Earth on its agents. • Kepler's Laws and Newton's laws of mechanics govern the motion of all three celestial objects. • The change of position, from day to night and from one day to another, of a given spot on Earth relative to the Sun and the Moon causes a change in the net gravitational interaction at this spot with the two agents.

Systemic dimension / facet		Sample benchmarks for Earth under Sun and Moon influence
Performance	Processes	Primary processes pertain respectively to the Earth's rotation around its axis (day and night), its elliptical orbit around the sun, with attention to its inclined axis of rotation (seasons), and the Moon's elliptical orbit around the Earth (tides): • Earth rotates around itself (around its virtual axis of rotation) once every almost 24 hours, and its rotational motion is governed by Euler's laws. • Earth moves in an elliptical orbit, with the Sun at one of the foci, once every almost 365 days. • The Moon orbits around Earth in an ellipse, with the Earth at one of the foci, once every almost 27 days (The Moon completes one rotation around itself during the same period). • The translational motion of Earth around the Sun and that of the Moon around Earth are governed by specific Kepler's and Newton's laws.
	Output	• The day-night cycle results from Earth rotation around its axis in front of the Sun. • The quasi-spherical shape of the Earth and the tilt of its axis of rotation cause: (a) sunlight to hit different regions of Earth at different angles of incidence in a given time, and (b) change, from day to day, of that angle of incidence at a particular spot on Earth as it orbits around the Sun. • The change of seasons in a given country results from the change, from day to day, of the angle of incidence of sunlight and not of the position of Earth relative to the Sun (Fig. 5). • The differential gravitational attraction by the Moon on different points on Earth (which is more significant than that of the Sun) results in sea and ocean tides.

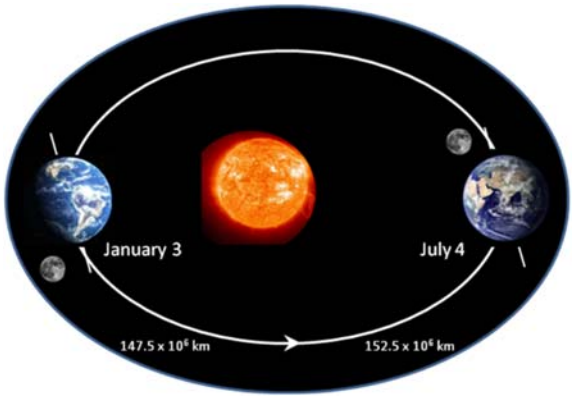

Figure 5. Graphic depiction of the Earth / Sun-Moon system.

The three celestial bodies are loosely depicted to show their relative positions on two specific days of the year when Earth is closest to the Sun (3 January) and farthest away from it (4 July), and when, contrary to popular belief, the northern hemisphere is in its winter and summer seasons respectively. Note how the tilted axis of Earth rotation makes sunlight hit the northern hemisphere almost vertically on July 4 but not on January 3. The opposite is true in all respects for the southern hemisphere.

Table 2

Partial outline of a social system (school) in accordance with the system schema

Systemic dimension / facet		Sample school benchmarks
Framework		Systemic governance and pedagogy whereby all dwellers (students, teachers, and all others) work with a hive mind, i.e., with a collective consciousness about, and trend to benefit of, individual potentials, and shared commitment to help each other evolve significantly for self-fulfillment and collective welfare. They do so under a clearly defined national vision for education and development, and in accordance with well-defined policies set by the educational system to which the school belongs♣.
Scope	**Domain**	Any institution of formal education, from early childhood to post graduate education, whether general education or technical and vocational education and training (TVET), pre-service or in-service professional development.
	Function	Providing quality education that equitably empowers all learners with systemic profiles (e.g. 4P profiles) for lifelong learning and excellence in life, and turns them into well-rounded global citizens who live with and for a strong national identity and who can significantly and willingly contribute to sustainable development at the local and national levels.
Constitution	**Composition**	A school consists of: • Learners / students. • Teachers and other learning agents (principal, coordinators, and all other instruction, administration, and logistics personnel). • Physical resources including the school premises, facilities, settings, and all sorts of equipment and learning means and devices (textbooks included) at the disposal of students and agents.
	Structure	All learning agents interact with each other and with students, and so do students with each other, with a hive mind, and in accordance with research-based systemic, pedagogical and administrative, tenets, principles, and rules that are in tune with current realities, and that meet dynamically and efficiently immediate and prospective needs and challenges of individuals and community.
	Environment	The local environment of a school consists of: • Students' parents / legal guardians. • Public and private education authorities that are directly involved in the school daily operations. • All educational and non-educational organisms and individuals in the local community with which the school is engaged in one form or another. The global environment of a school includes, among others: • Central governmental authorities. • Professional organizations in which learning agents are involved. • Local and international organizations on which the school draws for various reasons. • National and global factors that affect the socio-economic conditions of school dwellers and its local environment.

Systemic dimension / facet		Sample school benchmarks
Constitution	**Ecology**	Learning agents and students under the guidance of the former interact systemically and systematically with their local and global environment to optimize the efficiency of all school operations and the reification of all outcomes, especially learning outcomes and continuous development of students' and learning agents' systemic profiles.
Performance	**Processes**	All school operations are undertaken primarily to foster student experiential learning in the context of systemic, cross-disciplinary, and dynamic curricula whereby learning, instruction, and assessment (more "as" and "for" learning than "of" learning) are carried out harmoniously in tandem, and in accordance with research corroborated pedagogical tenets, principles, and rules.
	Output	Students' development of systemic profiles that empower them for: • Self-fulfillment, lifelong learning, and continuous success, even excellence, in all aspects of life. • Genuine and effective care for the welfare of others and the ecosystem. • Upholding and sustaining global citizenship with a strong national identity and pride. • Significant contributions to sustainable local and national development. Profiles in question have, among others, the following characteristics: • Dynamic 4P♥ traits with a widely acclaimed value system. • Systemic, cross-disciplinary, 21st century competencies that are readily and successfully deployable in real life situations. • Conscious metacognitive controls for turning every experience in daily life into an efficient learning (profile development) experience. • Creative and constructive executive functions for making and successfully carrying out fair, just, and judicious decisions in all aspects of life. • Insightful and critical axiological controls for the appreciation, accommodation, and support of significant and aesthetic accomplishments in arts, science, and all fields directly related to profile development and personal and collective welfare. Learning agents' continuous development of their professional profiles in line with, and to efficiently serve, the above purposes.

♣ An *educational system* consists of students and all *organs*, i.e., agents and agencies, involved in *formal* education, i.e., education offered in formal settings and, often, dedicated facilities, like school or university classrooms, to cohorts of learners so that they complete a well-defined program of study, normally as part of a specific curriculum.

An *agent* or actor is any person other than students involved in formal education, be it a teacher, a school administrator, or else, and an *agency* is a coherent body of such persons, be it public or private, local or national, along with physical resources and facilities at their disposal. Agencies include:

- PreK-12 schools, including nurseries.
- Universities and other tertiary education institutions.
- Pre-service and in-service teacher education institutions that are or not part of the above.
- Adult and continuous education institutions, with, like for all others, face-to-face or remote delivery.
- National (central) and local authorities like the Ministry of Education and school or educational districts.
- Educational research and development institutions, including those involved in curriculum design, textbook publishing, educational technology, and development of various other educational resources and media.

♥ Systemic education brings about learners with systemic profiles that embody professionals' patterns of success in modern life and that have at least four major general traits in common that would qualify them as 4P profiles. A 4P profile is the dynamic, constantly evolving profile of a systemic, well-rounded citizen empowered for lifelong learning and success in life, and characterized with progressive mind, productive habits, profound knowledge, and principled conduct (Fig. 6). The four P's are not absolute traits of a "one-size fits all" profile. They are universal "qualifiers" for distinct individual profiles which reliable research in cognitive science has constantly proven to be necessary for success – and excellence – in any aspect of life and in any era, especially our modern era.

Figure 6. 4P profile.

Progressive mind refers to an overall systemic and dynamic mindset with clear vision and determination to empower oneself and others for continuous growth and enhancement of various aspects of life.

Productive habits refer to practical and efficient cognitive and behavioral habits that are prone to systematic improvement and creative and advantageous deployment in various aspects of life.

Profound knowledge refers to a sound, essential, and coherent corpus of knowledge that readily lends itself to continuous development and efficacious and efficient deployment in various aspects of life.

Principled conduct refers to productive and constructive conduct in all aspects of life, while intuitively driven for excellence and guided by a widely and duly acclaimed value system.