**Chapter Title:** **Promoting Self-Directed Science Learning for All: Beyond the Scientist/Nonscientist Social Divide**

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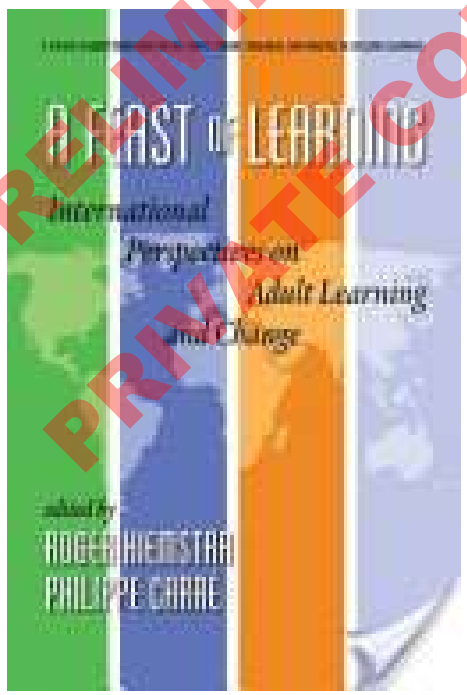



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**Chapter 7**

# Promoting Self-Directed Science Learning for All: Beyond the Scientist/Nonscientist Social Divide

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## *Focusing on Self-directed Science Learning*

Having enthusiastically discovered astronomy by myself as a child, I have since then dedicated a large part of my time to trying to make other people aware of the possibilities of "self-directed science learning" (SDSL). I believe there are two main reasons why it is important to pay special attention to the attitudes of the non-specialist adult not only towards scientific knowledge but also the idea of directing one's own efforts to learn and inquire more about it. The first reason concerns the importance attached to grades in scientific academic learning and the long-term negative effects that they can have on people's learning self-efficacy. Secondly, given the fundamental usefulness of scientific thinking as a means for checking the validity and relevance of self-acquired knowledge, it is important that people should feel free and confident in using their own *scientific* and critical thinking when engaged in learning.

## *The Importance of Grades in Science Curricula and Their Impact on Self-Efficacy*

As they pass year after year through the school system, individuals construct important relationships to knowledge, to the feeling of knowing, and to the act of learning. Memories of school and of the grades earned there play a key role in the formation of the self-judgments people form as adults concerning their capabilities as learners (Bandura, 1997). The status of academic science and the importance of scientific understanding have changed math grades into

a compulsory passport for highest level curricula. As a consequence, bad grades in science earned at school may not only leave many adolescents and young adults with a weak sense of personal *in*efficacy in scientific disciplines, but also leave them with a more general sense of low personal efficacy in virtually any domain of learning.

Since self-directed learning (SDL) is largely rooted in self-evaluative processes, the validity of knowledge acquired by means of SDL can be seen as problematic for both the learners themselves and their interlocutors. With respect to the problem of knowledge validity, various modes of scientific thinking, such as the phenomenological approach or Popper's (1935) criterion of falsifiability, can be seen as relevant tools for the self-directed evaluation of acquired knowledge and its value.

In order to enhance efforts at promoting SDSL, this chapter aims to relate a number of personal experiences in the field. These experiences go back to when I first began working as a facilitator and continue to the present time. Currently, I work more in the areas of project management and educational research. Five "dimensions" of these experiences will be discussed:

1. How the idea came about of setting up a guidance center as a new framework for long-term self-directed science and technology projects.
2. An explanation of the link between such a guidance center and the pursuit of science and technology literacy goals.
3. How the divide between leisure and work time impacts the guidance center and raises the question of learning from a lifelong learning perspective.
4. An answer to the question of whether French *Culture Scientifique, Technique et Industrielle* stakeholders (henceforth CSTI stakeholders) share in the belief that there is a connection between long-term SDSL counseling and their own goals.

5. How we can describe the different CSTI stakeholders' views as regards SDSL.

## *Establishing a Counseling Center as a New Framework for Long Term Science and Technology Self-Directed Projects*

As a young man studying at university in the late sixties, I began promoting SDL as a facilitator in astronomy clubs and summer science camps. I spent the seventies and eighties working for the French national union of science clubs. This job was at the heart of the field of scientific leisure and I was training both teachers and trainers how to use experimental methods in science and technology education. In 1990, at the *Cité des sciences et de l'industrie* (the French National Science and Industry Center located at *La Villette* in Paris), I proposed and managed the project *Cité des métiers de La Villette.* The project's main aim was to establish a guidance center that would facilitate people's access to self-determined lifelong learning. This Professional Trade or Occupation Center (roughly translated from the French *Cité des métiers*) has now been open and operating since 1993. I still manage it while also working as a volunteer facilitator in the French network of science clubs and serving as President of the *Association française d'astronomie*.

As my first involvement in SDSL was largely based on individuals' club participation and on short training sessions, my initial conception of SDL was rooted in relatively shorter episodes of learning. What people set up for themselves were short-term projects, although now looking back, it is clear that some of those projects had the potential to determine truly lifelong career paths as astronomers, engineers, photographers or technicians. To my mind, the new challenge brought about through the creation of the *Cité des métiers* is to help more people define and implement longer-term self-determined learning projects, which in some instances

will lead to new career paths and allow them to take better advantage of lifelong learning possibilities.

Working to empower people by helping them develop their lifelong learning potential may be seen as pursuing two different goals, one more focused on the short-term, and the other on the long-term. The shorter-term focus aims to help people as often as possible in initiating a short-term SDL strategy in order to acquire the new knowledge needed to solve contingent problems or satisfy an occasional curiosity. The second, longer-term focus aims to support individuals in their successful pursuit of new vocational pathways which may last a lifetime. This second level of empowerment was the one we were intent on promoting when we established the *Cité des métiers*.

### *The* Cité Des Métiers *Guidance Center and Its Results*

The *Cité des métiers* is a job and guidance center open to all individuals. It was founded in the spirit of the French "*éducation permanente*" (usually translated as "community education"), a tradition in adult education that seeks to empower men and women by uniting the efforts of non-profit organizations and public agencies and by blurring the divide between work and leisure. The main idea was to capitalize on the structure and resources of the nearby *Cité des sciences et de l'industrie* and to create an entirely new kind of guidance center in association with the main counseling organizations working in the fields of guidance, employment, training, and professional life. Opened to both adults and youth, this center can be seen as a kind of lifelong learning "tourist information office".

**The *Cité des métiers* can be seen as a kind of lifelong learning "tourist information office" built in association with the main French counseling organizations. It can also be seen as a new way of involving adults "not already interested" in scientific issues.**

After two decades of experience and more than four million users (including a half-million who had at least one personal counseling interview), the relevance of such a center has been proven from both a quantitative and qualitative point of view. For example, external evaluations reveal that the overall rate of satisfaction is very high (over 85%). Further evidence of this relevance stems from the fact that an international network of 31 similar centers was progressively developed in seven other countries using our *Cité des métiers de La Villette* as a model. Those centers are labeled and trademark registered through a free franchising system co-administered by an ad hoc non-governmental organization established just for this purpose, the International Network of *Cités des métiers* (Las Vergnas & Thomas, 2011). Additional information can be found at http://quadec.citedesmetiers.org/CDMEN.pdf .

## *Explaining the Connection Between our Guidance Center and Science and Technology Literacy Goals*

### *An Obvious and Relevant Connection*

One of the key ideas that led to the founding of the guidance center was that it help anyone find relevant information about any kind of occupation. The goal was not only to promote jobs that could be described as scientific, but rather help anyone forge and follow a pathway that might increase their professional qualifications. The inherent connection between such a "professional empowerment center" and the general aims of a facility such as *La Villette*,

devoted to industry, science, and technology, is clear given the extent to which the evolution of all three sectors alters and affects qualifications and professions far beyond those generally perceived as "scientific."

The idea that all professional qualifications are more or less related to scientific and technological literacy was a key point. Indeed, one of the most important aims was to broaden *La Villette*'s role in support of public understanding in the areas of science and technology. The *Cité des métiers* was an opportunity to go further than what French policymakers usually call *Culture Scientifique, Technique et Industrielle* (CSTI), i.e, using cultural leisure activities to engage in practical research concerning the impact of technological change on professions and which uses people's learning trajectories as a self-directed way of finding solutions to problems that preoccupy them or are of personal relevance. Thus, in France, CSTI is used to designate what is elsewhere referred to as "public understanding of science and technology" or "scientific and technical literacy" (Schiele, 1994). This terminology came into use following the formulation introduced by the French physicist Jean-Marc Levy-Leblond in the 80s (Levy-Leblond, 2004) and which suggested that science could be "put into" culture. The acronym CSTI has been widely used over the past two decades, even though it suggests the existence of a separate scientific culture, which is contrary to the original idea of integrating a scientific perspective into the general culture. Furthermore, the term nowadays carries an additional ambiguity due to the fact that it refers specifically to CSTI programs and settings as well as generally to the scientific dimension of lay people's knowledge. In this chapter, however, I use the term to mean industrial, technological and scientific literacy.

The question may be asked as to whether it was relevant to include such a pragmatically-oriented counseling center inside a CSTI center. Today, virtually all professions are evolving,

specializing, or becoming configured in new ways due to technological innovation and development as well as new ways of organizing work and the impact of new and complex societal issues. The advent of information technology and of major social challenges such as sustainable development along with the ever-accelerating circulation of goods, people, and ideas have given rise to a world in which there is no profession that does not feel the day-to-day impact of innovation, either in terms of tools, materials, methods or market. Labor and qualification issues are directly concerned with public understanding of science and technology. In this regard, an important aspect of the *Cité des métiers*' self-professed mission was that professional literacy can be seen as synonymous with technical literacy, and that therefore, scientific and technical literacy includes professional literacy. Due to this strong connection between technological and professional change, our contention was that it was pointless to label an information center as an CSTI center unless it included explicit information about changes in occupations and jobs in a highly dynamic work environment.

***Involving* a priori *uninterested people in Self-Directed Science Learning***

The *Cité des métiers* was also a new way of increasing the outreach of CSTI by striving to involve adults who, *a priori*, are not interested in scientific issues. This is one of the main paradoxes of science awareness as we have experienced it for years about astronomy popularization: Any proposal based on curiosity about a specific topic reinforces the social difference between those already interested and those not yet interested. In point of fact, traditional science promotion activities often create the unintended social effect of increasing inequalities in knowledge instead of reducing them.

Even when managing to reach a large audience, as when, for instance, setting up a TV broadcast to spark such personal curiosity, the problem remains how to transform an episodic

"spark" of interest into a longer-term involvement in and commitment to SDL. Arroyave (see chapter in this book) identifies the related issue of Education-Entertainment as a longer-term, alternative way to learn. This type of situation arises in France each summer when a national awareness event called the *Nuits des étoiles* (Nights of the Stars) is held in order to promote public knowledge and understanding in the field of astronomy. This popular event has become *the* summer encounter with the sky. More than 400 events are organized over the course of three consecutive days and several thousand volunteer organizers invite ever greater crowds of people to come and observe the heavens and discover astronomy. Each summer, these collective "star parties" bring together about 100,000 people. Several million sky maps are printed and distributed by newspapers, while the associated live TV-program broadcast on the national channel *France 2* reaches between 2 and 3 million spectators. Since 1991, the *Nuits des étoiles* has helped develop organizations at a local level and increased general public awareness and interest. It has also contributed to strengthening and professionalizing the French network of astronomy clubs. Although this annual multi-partner program succeeded in substantially increasing the total number of people who participate in it over the ten-year period from 1994 to 2004 (increasing from 1.5 to 2.5 million), it has had no effect in terms of developing astronomy SDL activities, such as clubs or summer camps (Las Vergnas & Piednoël, 2011).

Classical exhibitions, lectures, or even clubs cannot "solve" this paradox, but a counseling center based on personal problem-solving might manage to do so. It might succeed where other options fail because its main audience is not people curious about scientific progress, but rather those genuinely "preoccupied" by problems of a scientific and/or technological nature. Given that such individuals are more numerous and are strongly motivated

to find solutions, the counseling center was launched with the belief that reaching these people would contribute in an innovative way to the reduction of social inequalities in learning.

### *How the Divide between Leisure and Work Impacts our Guidance Center*

#### *No real link between the uses of Cité des métiers and the visits of Science exhibitions*

In the first years following the opening of the *Cité des métiers* in *La Villette*, we were surprised by the fact that adults participating in exhibitions and leisure time activities did not often mix with *Cité des métiers* users. We also observed that relatively few visitors used both the *Cité des métiers* and the other CSTI leisure components, such as the exhibitions or popular conferences. However, approximately a third of all visitors did actually use the La Villette science and technology library in addition to *Cité des métiers*.

Of course, these observations do not question the relevance of the *Cité des métiers* and its main guidance aim, but they do call into question its historical relationship with the *La Villette* Science and Technology Center as well as our hypothesis about using such counseling centers as new pathways to SDL in science and technology.

In fact, the conclusion I have drawn from such observations (Las Vergnas, 2006, 2011) is that the separation of uses between the *Cité des métiers* and the rest of *La Villette* is not best accounted for in terms of a lack of interest in scientific and technical matters, but rather is best explained in terms of another strong social divide having to do with the way people organize their time. This work time / leisure time separation is one parameter that seems to discourage individuals from making transversal visits of multipurpose centers such as *La Villette*. By "transversal visits" I mean the carrying out of consecutive leisure and work episodes, such as a professional counseling interview or workshop, followed by a visit to an exhibition, for example. From a social point of view, it would seem that the acquaintances and relatives with whom one

attends a professional counseling center are not the same friends or relatives with whom one decides to visit an exhibition on one's leisure time. Personal time organization is more based on social rhythms and family management than on lifelong learning opportunities.

***Leisure/work time divide and* éducation permanente *conception***

Such observations raise more general questions for researchers working on lifelong learning issues. Carré (1997) and Carré, Jézégou, Kaplan, Cyrot, and Denoyel (2011) refer to a transversal "learnance" which is defined as a sustainable set of dispositions favorable to learning in all kinds of educational situations. This "learnance" conception fits well with French *éducation permanente* views. Obviously, people learn in both situations: Leisure moments include learning sequences (often pre-organized through the leisure merchandizing process where leisure is seen to be an expected commodity) as well as periods of working time that include learning process decided by a human resources team.

However, organization of personal time is increasingly split along functional lines: most people experience a succession of formatted periods: the question is to understand how those *éducation permanente* and "learnance" concepts are affected by this growing divide separating leisure and working time. If people experience such a strong separation, learning skill may appear only related to work and effort and therefore not relevant during leisure time except for the goal of gaining immediate self-satisfaction. Is it however possible for learners to develop an attitude of "lifewide learnance" which will be as relevant to their free-time occupations as it is to their professional ones?

***Lifelong Learning Can Be Supported Over Time***

To go back to the experience of *Cité des métiers* regarding lifelong learning self-development, I obviously did not expect all users to become directly involved in a technical or a

techno-scientific SDL episode as soon as they entered our counseling center. What I did have in mind, however, was that they would naturally be interested in looking at their own technical and techno-scientific skills, and that most of them would consider using vocational tools, such as skills assessment and validation of prior experience or that they would get involved in professional SDL pathways. In that sense, the *Cité des métiers* was a way of starting deeper learning SDL projects, redefining the meaning of lifelong learning from a short-term vision of successive SDL episodes at any age to a longer-term vision of lifelong pathways.

This change in perspective means that despite the low ratio of transversal uses of *La Villette*, the *Cité des métiers* is still considered to be a relevant long-term scientific and technical SDL developer (Las Vergnas & Thomas, 2011). Since 2001 we have also set up inside La Villette - *Cité des sciences et de l'industrie* another counseling center called the *Cité de la santé*, focused on long-term health problems.

### *Is There A Shared Conception of the La Villette Approach?*

As explained earlier, an international network of 31 *Cités des métiers* has now been established in eight different countries, modeled after the first one which opened in Paris. Although all are empowerment centers, similar to and labeled after the *La Villette* model, only one of them is in link with a Science and Technology Center (in Cotes d'Armor, North Brittany, where the *Cité des métiers* is a part of *L'espace des sciences et des métiers*, a provincial center for CSTI).

In reality, this shows that almost all the partners and stakeholders of these *Cités des métiers* have not considered the building of specific links between professional considerations and lifelong guidance counseling with a center dedicated to science, technology, and industry awareness to be a priority. In a few cases, they have not succeeded in building such a link. This

is not a surprise and only highlights the fact that the creation of a *Cité des métiers* is considered to be useful in itself and is often, therefore, the result of an initiative taken and completed by a consortium of employment, guidance, and economic partners, without any link whatsoever to local CSTI policies.

The observation that CSTI official partners seldom get involved in setting up *Cités des métiers* raises more questions about the relationship we had originally imagined between SDL, lifelong learning views, and the institutionalization of CSTI. In fact, most of the centers for CSTI became involved in promoting what they usually called the fostering of scientific vocations, having specifically in mind researchers and engineers. However, apart from the *Espace des sciences et des métiers* in Brittany with its own *Cité des métiers*, no one has developed a wider vocational guidance or a SDL permanent organization. This most likely means that they did not take into account the notion of professional life, such as work environment, qualification, and techniques, nor jobs or occupational knowledge, as a part of what they understood as CSTI.

### *Describing the Different CSTI Stakeholders' Views About Scientific SDL*

It is important to understand why these issues supporting either people's self-directed learning professional projects or understanding vocational training opportunities did not interest CSTI stakeholders. Moreover, what were their precise goals and how did they intend to reach them in terms of training or learning?

#### *Recurrent Policies Without Any Macroscopic Result*

When trying to evaluate various stakeholders' CSTI policies, observations have in fact been made that in France, at least, those views promoting a cultural knowledge of science and technology have been repeating themselves almost identically for thirty years. Since the end of the seventies and the eighties, official reports published either by the Senate, public agencies, or

ministries, describe the necessity of giving priority to the CSTI issue (Schiele, 2008). This makes these policies appear as a kind of a social prophecy. In the "class of the new" Barbrook (2006) comments on social prophecy in the following way: "Just like the predictions of technological determinists, […] prophecies of the future are primarily prescriptions for the present. Knowing what will happen is a claim to control what is happening. […] thinkers are still promoting their ideological programmes in the guise of sociological analyses" (p. 47).

Yet, learning objectives are reached at an individual or micro scale. In essence, many plans have proven their relevance in facilitating self-directed appropriation of scientific methods or knowledge, such as scientific leisure clubs or individual uses of libraries, as well as self-directed professional training projects (in the case of the *Cité des métiers*). But in contrast, as these systematic repetitions demonstrate, at the more global, societal level, nothing seems to show any progress regarding the main issues that trouble or intrigue those CSTI stakeholders. The global relationship to science within the population as a whole can also be seen from a macro point of view in terms of the ratio of adults involved in academic science SDL. More precisely, academic scientific knowledge and activities seem as distant as ever from a majority of the population's interests. In other words, no progress seems to be taking place regarding the appropriation or use of scientific knowledge at the scale of the society as a whole.

***Science Literacy and School Curricula Social Consequences***

At this macro-social scale, I have been able to show that views of science literacy can be ambiguous and often do not take into account school curricula consequences (Las Vergnas, 2011, 2012). On the one hand they do not define what *scientifique et technique* views precisely specify and, on the other hand, they do not pay attention to the fact that relation with science in a modern society is determined by the manner in which education in these fields is designed and

carried out at school. In fact, CSTI views hold it possible to improve both elite detection (finding the best pupils as selections for future scientists) and knowledge sharing; furthermore, they forget that the educational system socially categorizes pupils into groupings of one quarter scientists and three quarters non-scientists (see Figure 7.1), giving them bad grades and thus causing a feeling of personal self-inefficacy for everything related to science.

[Figure 7.1 goes about here]

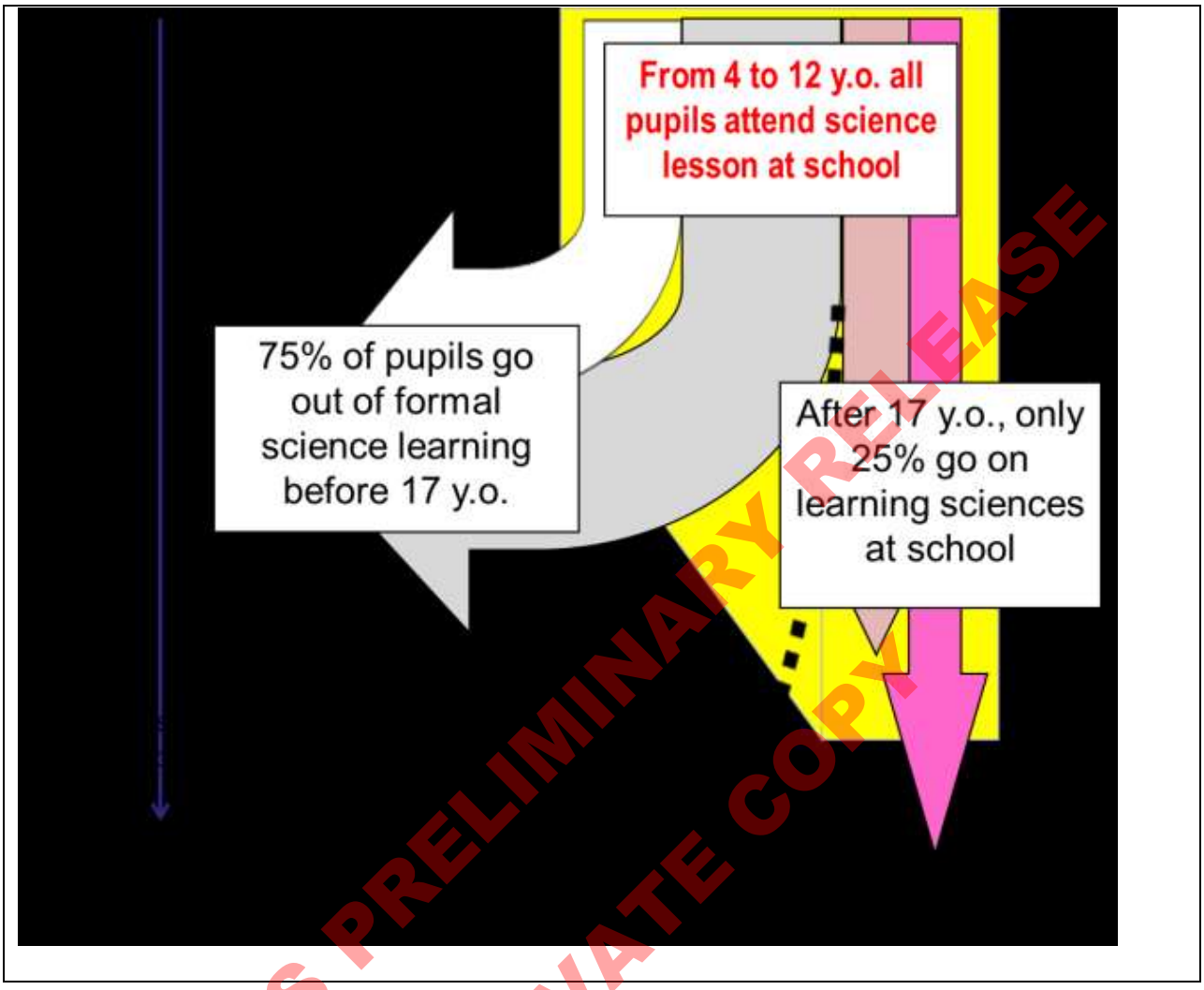




Figure 7.1. *Science Categorization at School*

My hypothesis is that those pupils so categorized as nonscientists are led to develop a motivation obstacle, that I call a conative obstacle (Las Vergnas 2011), which, adding to the natural cognitive obstacles, literally teaches them to accept this categorization. It may even become a self-fulfilling prophecy according to which they are not able to deal anymore with any sort of science-related knowledge.

**Numerous nonscientists pupils are trapped in a self-fulfilling prophecy according to which they think they are not able to deal with any sort of science-related knowledge.**

In addition to that, the normal channel of CSTI stakeholders is through lectures and exhibitions about issues that are self-selected and that generally are linked to what is taught in school as science. This means that CSTI programs are managed more as a top-bottom prescription than a bottom-up process that would help people deal with self-determined topics emerging from their own questions, from problems that bother them, or in which they have a strong personal interest. This point of view creates what I have called a scholastic CSTI (Las Vergnas 2011), in the sense that it does not give its consumers much opportunity to enlarge their conception of science to include the scientific and technological dimension that can be found in many daily life episodes experienced by everyone (Levy-Leblond, 2004; Schiele 2008). Thus, the epistemological divide between scientific knowledge and knowledge originating in day-to-day life finds itself reinforced. Instead of recognizing the opportunities of science SDL and of acculturation of science brought about by technical practices, it introduces another obstacle, the scholastic view.

Going further with this idea, by the addition of conative and scholastic obstacles to the cognitive obstacles (Bachelard, 1938), I hold that school curricula memories can be seen as responsible – in countries such as France – for a science divide that discourages more or less three fourths of the adult population not only to develop science SDL, but also to use or self-acquire science methods or knowledge for daily problem solving.

**We have to consider three main obstacles to science SDL, the cognitive one called epistemological obstacles, and two others: a conative one, working as a self-prophecy, and a scholastic one, due to the fact that daily science does not look like school science.**

***Communication More Than Learning Policies***

As others have shown it (Schiele, 2008), as far as adults are considered, CSTI programs are more targeted on organizing dialogue between scientists and nonscientists than on fighting that science divide or those post school obstacles by promoting nonscientists' SDL. Currently, most CSTI stakeholders agree that the problems they have to solve is the lack of interest for science and/or even the lack of self-confidence for tackling any problem resorting to science. They conclude that the knowledge deficit model that was in use thirty years earlier, as a guide for CSTI actions, can no longer be seen as accurate in reestablishing confidence between the majority who are lay people who have not been seen as scientists in school and the scientists. So, as far as adults are concerned, the main new goal for CSTI or a public understanding of science is suggested by stakeholders as building a link between science and society. . For instance, the European Commission has recently renamed its former public understanding of science program as a science in society program.

To achieve this goal, they mainly imagined bringing together people in public debates or in smaller more innovative citizen science programs such as workshops or sessions to build consensus. This also could include translational or participative research within the framework of what they call outdoors research (*Sciences de plein air* in French), such as community participatory action research programs.

Apart from those specific activities of outdoors research activities in which nonscientists are recognized as partners able to share experiential or popular knowledge, the science in society programs intend to organize dialogue between nonscientists' opinions and scientists' knowledge. Today, very few CSTI stakeholders think it possible to imagine the science divide overcome at a micro level by personal acquisition of knowledge or mended at a macro level by a reorganization of school curricula. As a matter of fact, most of the researchers working on CSTI programs are involved in information communication more than in education, and those programs do not actually question this divide as if it were an intangible social fact and not a social construct.

**Science SDL Positive Deviants**

I have observed in former papers that some rare situations for adults still exist which can be considered as cognitive CSTI as far as they allow self-directed learning to go beyond their past schooling experiences as children and youth. In such situations non-scientist adults are not constrained by the memory of their poor grades in school and consider themselves clever enough to acquire scientific knowledge and use it to solve problems.

In order to identify and allow for a better analysis of this kind of activity, I have already suggested that CSTI for non-scientists must therefore be categorized into two groups of action (Jouet, Flora, & Las Vergnas, 2010). The first one organizes the dialogue between scientists and non-scientists without questioning their knowledge divide. The second, which fosters the appropriation of knowledge and of approaches that overcome the scientific-unscientific stereotypes, belongs to historical currents in self-directed learning, striving for new knowledge and empowerment (see categories 3 and 4 on Figure 7.2).

[Figure 7.2 goes about here]

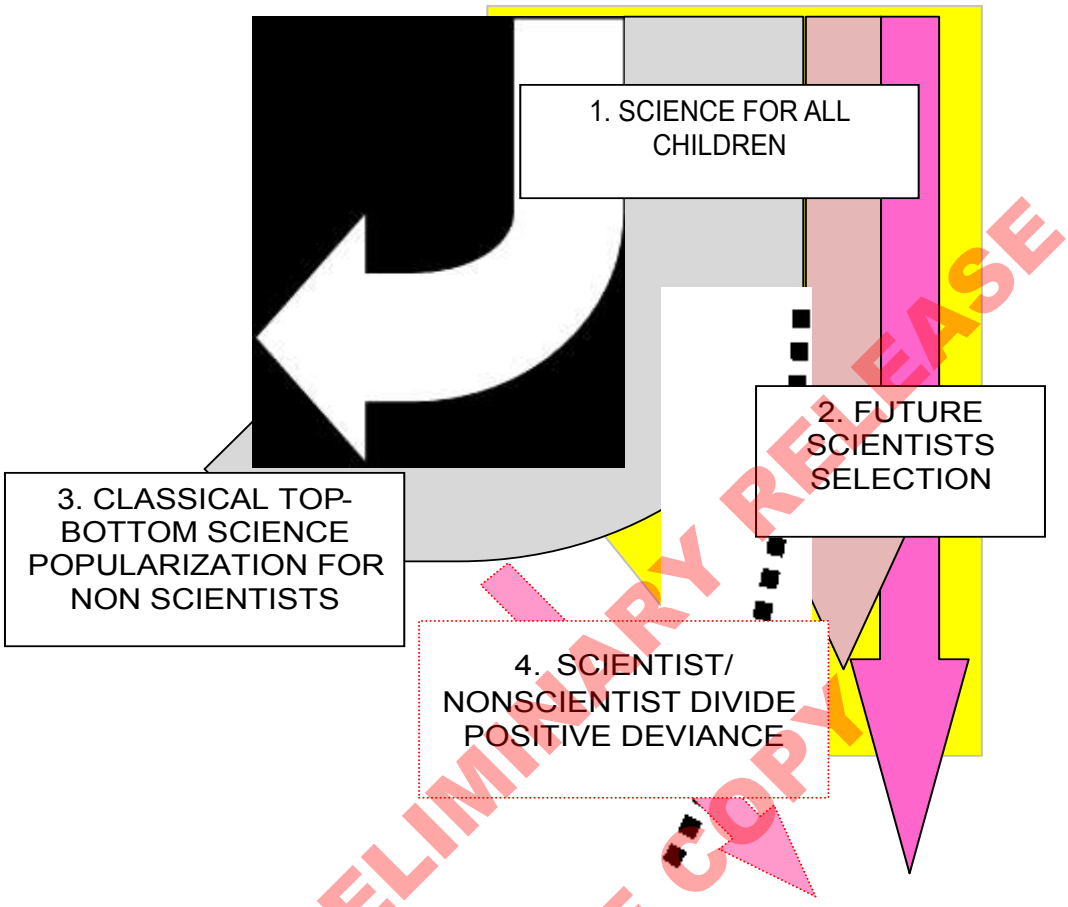


Figure 7.2. Typology of CSTI actions



In many respects, such people could be seen as positive deviants, as noted in Singhal's chapter for this book (Chapter 9, Applying Positive Deviance to Education and Learning). For example, my colleagues and I have worked on groups of individuals that made the best of a chronic illness through life-acquired knowledge, (Jouet, Flora, & Las Vergnas, 2011) and Brown (1987) on activists taking part in surveys related to local epidemiology. People finding fulfillment through experimental scientific leisure activities such as astronomy clubs members can also be added to this category.

**Little Science, Big Science, Impure Science, and SDL**

As a SDL promoter, I am most interested in the non-scientists because what they do calls into question the scholastic and conative limits giving them the opportunity to look for a new kind of knowledge, what could be called self-scientific knowledge. It is also a way to deal with a famous Price's question (Price, 1963) about the classical "Little Science" useful for local problem solving currently becoming the "Big Science" useful as a globalized socio-economic process. Keeping this Price's terminology of Little (as local) Science and Big Science in perspective, we can refer to the concept of "Impure Science" that was introduced by Epstein (1996) to qualify the medical SDL activities that have been developing with the AIDS crisis since the eighties.

***Implications***

Those Impure Science episodes (laymen involved in self-clinics and popular epidemiology or scientific clubs) show evidence that a socially constructed divide between scientists and nonscientists – built in our post-modern societies by school curricula – do not draw an irreversible destiny for all. In some specific cases, motivation and efficacy can be strong enough to empower some nonscientist adults (i.e., without any science degree) in re-discovering science SDL opportunities, not only as popular science readers but as scientific knowledge co-producers linked with academics. However, such positive deviants able to re-integrate later the scientists' category and co-produce knowledge are very few. They certainly cannot become the majority of the population, because of the level of motivation and efficacy requested to go through conative and scholastic obstacles. Because they are very few, they could even be seen as belonging to a normal rate of mistakes in the school categorization: People who should have

been seen and selected as scientists at school and that have corrected their false categorization later.

**Some specific cases of science learning positive deviance show that socially constructed divides between scientists and nonscientists are not irreversible destinies for all.**

In fact, this discussion reveals important underlying questions for SDL promoters: (a) How do ordinary people (neither graduated scientists, nor amateur scientists) live this fact of a separation between scientists and nonscientists? (b) How do memories remaining from school times interact with their abilities when they are faced with questions or problems brought by day to day life or their own reading efforts? (c) Are they still able to master a kind of scientific way of thinking, despite the school prophecy of not being able to solve science problems?

As it has been demonstrated at the beginning of this chapter, those issues are key items for SDL promoters, because mastering what can be called a scientific way of thinking (i.e., logical reasoning, the experimental method, and evidence based demonstration) is compulsory to allow relevant SDL, because such methods are crucial to enable self-directed learners to check and verify the relevance of their knowledge. When learning in a formal school or with school books, learners can assume that the relevance of what is taught to them is established by the academic authorities who are their knowledge providers. *A contrario* relevant SDL implies relevant self-evaluation of what is self-acquired.

**The adjective "scientific" must remain understood as meaning a perspective accessible to anyone and not only to a specific category of persons, the scientists.**

That is why, with the worldwide industrialization of science described by Price (1963), SDL promoters have to face a key problem: Although this big science movement strengthens the scientist/nonscientist social divide conception because it specializes people and goes with hard science selections at the school level, SDL promoters have to fight to allow those who have not graduated in science to keep whatever little (local) science abilities they have for their own. To say it another way, they have to pay attention such that the metamorphosis of any academic science into pieces of a bigger science does not entail the abandonment of any existing science abilities.

In that perspective, teachers and SDL promoters have to take care that the adjective "scientific" remains understood as meaning a perspective accessible to anyone and not understood as meaning a specific category of persons, the scientists, seen as owners of the power of scientific method and a scientific way of thinking, a contrario of the laymen.

The appendix presents various web sites that consider some of the arguments of this chapter.

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## Appendix

### *Webography of Related Internet Sites*

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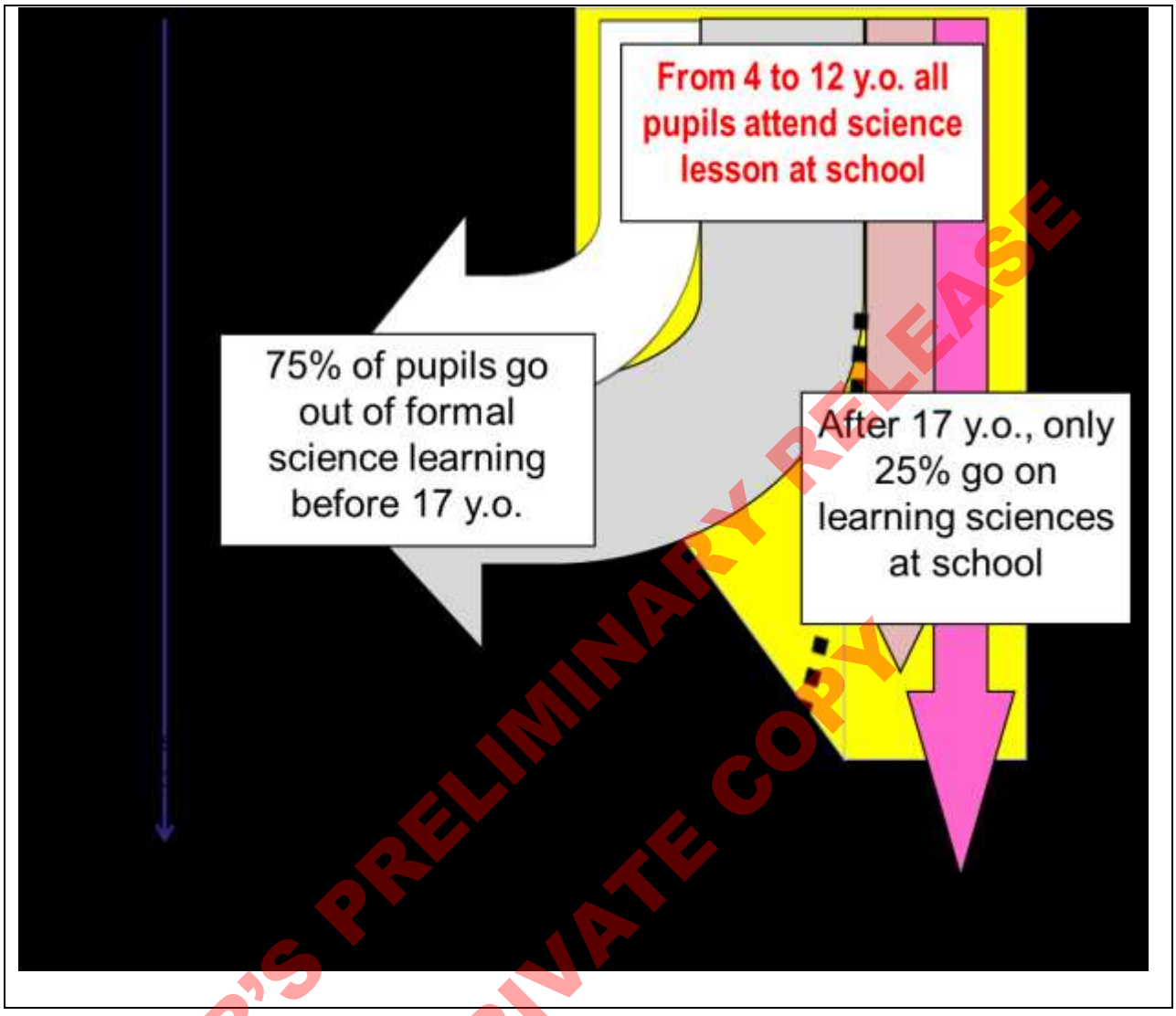


Figure 7.1. *Science Categorization at School*

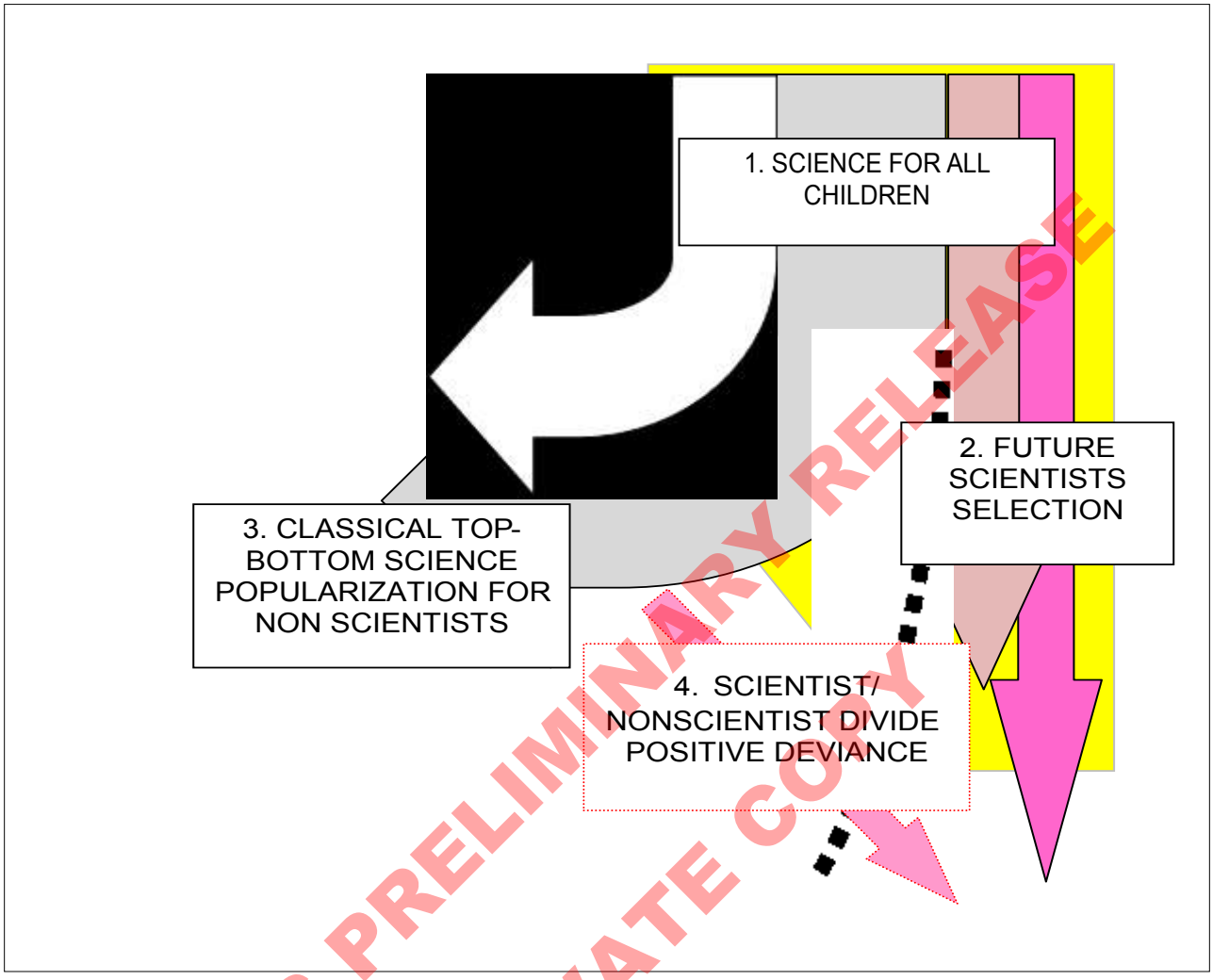


FIGURE 7.2. *Typology of CSTI Actions*