# IMPORTANCE OF STUDYING THE INDIVIDUALS' CONTRIBUTIONS AND THE SUPPLEMENTARY VARIABLES IN S.I.A.: PROFILES OF LEARNING ATTITUDES ON SCIENCES RELATED SUBJECTS IN FRENCH ADOLESCENTS ATTENDING SCHOOL

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**TITRE :**

**Apport de l'étude des contributions des individus et des variables supplémentaires dans le cadre de l'A.S.I. : Profils d'attitudes d'apprentissage à l'égard de sujets relatifs aux sciences chez des adolescents français scolarisés.**

**ABSTRACT**

The present study reports results obtained from analyses of the ROSE questionnaire data collected on a sample of 2124 French 15-years'old students *(http://folk.uio.no/sveinsj)*. This questionnaire offered the opportunity to find by Statistical Implicative Analysis (SIA) stable attitudinal learning orientations derived from close and coherent choices of significant subgroups of students on a large number of learning targets related to sciences On the 109 targets proposed to the students, 33 can be considered as transversal subjects on the relation of sciences and history, everyday life or issues in our society and are thus defining most of the attitudinal goals proposed in the new French reform aimed at developing scientific literacy (SL). We found that SIA of the 2124 students' profiles of responses permitted to define 17 idealtype profiles describing the main tendencies in the French adolescent' population concerning their willingness or unwillingness to learn on sciences objects in our culture. Surprisingly the SIA demonstrates that two profiles with opposite affective orientations concentrate most of the subjects related to SL. This means that some students have identify and isolated such subjects as forming a specific coherent learning theme on which they want to engage or not learning efforts. The model of the classroom group determine by SIA gives important information for the teachers applying the new reform goal since knowing the two subgroups sizes and the contents and structures of their learning orientation can help them in the design and the management of an activity on SL related subjects. We have here supplemented the primary information given in the SIA model by information on the contributors forming the two optimal groups of students expressing the opposite profiles. Such information was obtained by a secondary analysis of the SIA data introducing supplementary variables built on various responses made by the students across the questionnaire. The questions were selected to inform individuals' living environment characteristics. This leads to statistical analysis of the contribution to the two profiles of interest of supplementary variables reflecting a trait of the students' living environment. We observed that the two students' subgroups, one adhering to the new SL goal of the reform the other rejecting it, present significant differences in the expression of traits relative to their family environment, social environment and natural environment. These observations suggest that factors of the living environment have some impacts on the adolescents' learning orientations determining their willingness and unwillingness to develop their SL. These additions of information given on the students of the two optimal groups should help the teachers to identify and stimulate the expressions of the students'

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learning attitudes on SL related subjects as much as the causes that lead them to built such attitudes.

***Key words:*** *Students' diversity-Scientific literacy- environmental factors- motivation- French reform-sciences education-group dynamic*

**RÉSUMÉ**

Nous reportons ici des résultats obtenus lors d'une analyse nationale faite sur 2124 élèves de 15 ans utilisant le questionnaire ROSE (http://folk.uio.no/sveinsj). Ces données offrent de nombreuses opportunités de comprendre comment cette nouvelle génération d'adolescents peut ce comporter en tant que groupe au sein de la classe de sciences. Le questionnaire propose en particulier une liste étendue de 109 cibles d'apprentissage relatives aux sciences dont 33 touchent des sujets transversaux, cibles particulières des nouvelles réformes visant à développer des attitudes positives et une culture scientifique nécessaire à tout citoyen. Dans une étude SIA antérieure ceci nous a permis de décrire 17 profiles idéaltypes représentant des orientations d'apprentissage stables et raisonnées par des sous groupes de cette population. Deux de ces profiles expriment des orientations d'apprentissage associant des attitudes positive pour l'un et négative pour l'autre à l'égard des mêmes sujets touchant typiquement aux relations entre sciences et problèmes sociaux, culturels ou quotidien. La concentration dans ces deux profils de la quasi-totalité des sujets proposés par le questionnaire sur le rapport sciences et société signifie que les contributeurs à chacun de ces profiles ont établi des règles de conduite sélectives à l'égard de ces objets d'apprentissage impliquant la science dans leur société. Savoir quels facteurs pouvaient intervenir dans ces deux orientations d'apprentissage qui sont au centre des préoccupations de la réforme de l'éducation scientifique est essentiel. Différentes sections du questionnaire permettent de définir des variables ayant trait à l'environnement de vie de l'élève. Grâce au programme d'analyse inclus dans le programme CHIC nous avons pu considérer d'un point de vue statistique la contribution des variables supplémentaires (caractérisant les élèves par ces traits de leur environnement de vie) aux deux profiles exprimant des orientations d'apprentissage soit positive et soit négative à propos des sujets relatifs aux sciences dans leur société. Ces analyses montrent que l'environnement matériel et humain au niveau du foyer familial, des situations sociales, et dans la nature jouent statistiquement un rôle dans les motivations à apprendre opposées des deux sous groupes. Nous proposons que l'enseignement de la culture scientifique prenne en compte et utilise le model des profiles idealtypes décrits par l'analyse SIA des attitudes d'apprentissage à l'égard de sujets relatifs aux sciences et considère les informations contenues dans deux profiles d'attitudes focalisées sur les sujets relatifs à notre société et culture scientifique complétées par celles des analyses de traits des deux sous groupes d'intérêt. Ceci devrait permettre d'anticiper la diversité des vécus et des représentations qu'ont les élèves des objets scientifiques rencontrés dans leur société et de proposer des activités permettant l'expression des affects et des attitudes afin d'utiliser les point de vues des élèves comme base au développement de la culture scientifique nécessaire au citoyen.

***Mots-clés :*** *diversité des élèves ; culture scientifique ; facteurs environnementaux ; motivation ; réforme française ; éducation des sciences; dynamique de groupe.*

# 1 Introduction

Recently the sciences education community has turned its collective attention to the idea that a content called "scientific literacy" should be taught to the future citizens of our modern societies. National politics on education and scholar systems progressively accommodate this new concept of "scientific literacy" in reforms aimed at following the international consensus on the fact it should be a new goal of the sciences curriculums.

This term of scientific literacy (SL) became popular in the 1990's in response to the need of a more operational idea than le slogan "sciences for all" which 10 years earlier was proposed by UNESCO (Lee & Luykx, 2006, Osborne 2007; Robert, 2007; Ryder, 2001). However, the idea of "scientific literacy for the citizen" may not be more operational than the "sciences for all" project in spite of some formal presentation in official programs of the science education of a SL related goals. In France these new economical, political and ideological values on the need for our scientific cultures to educate through scholar scientific programs certain level of scientific literacy were officially incorporated in the curriculums through the 2006 reform of the lower secondary school (JO L 394, 2006). No investigation was made on the diversity in students' prior knowledge awareness and willingness to learn sciences in order to become future citizens having "a reasoned imagination, being open minded, interested about sciences and technology progresses" , having "observation sense, curiosity for the causal discovery of natural phenomena, critical sense allowing: the distinction between the proved, the probable or the uncertain, the prediction and the prevision" as well as "the capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions"and finally being able to "understand and help make decisions about the natural world and the change made to it through human activity". The reform assumes that the new organization in themes unrelated to the discipline will permit to the sciences teachers to obtain motivated students that will develop these positive attitudes

In any case it let teachers with the task of teaching the new SL goal without knowing how the students may respond.

This work is following a work aimed at developing a model of the sciences class group of adolescents that should help the teachers in the thematic aspects of the reform (see Montpied et al 2010). We are therefore using the data obtained by ASI demonstrating that significant students' subgroups of the 15 years old French population express positive or negative learning orientations comprised of coherent system of stable and reasoned attitudes ( see Fazio, 2007 for the definition of the stable attitudes and attitudinal systems). These learning orientations are focalized on related subject defining themes which object is to know about matter involving sciences or its relation with the everyday life, the society and the world issues. We demonstrate that almost all the subjects proposed by the rose questionnaire on these last aspects central to the new reform goal are concentrated in two learning orientations sustained by two groups of contributors with opposite affective orientations on these subjects.

In the present work we are therefore restraining our assessments two years after the reform introducing the new SL goal to the two subgroups expressing the profiles of positive and negative attitudes on SL related subjects. Our previous data show that the subgroup with negative affects varied from 18 to 30% depending on the school type considered and suggesting that in the less successful students (professional school) we found the highest number of future citizens that are not interest in knowing about issues relating sciences with their society and everyday life. With other aspects of our previous results it seems likely that some origins of the positive and negative reasoned and stable attitudinal orientations on SL subjects can be found in the adolescents' living environment.

We are thus proposing here to use ASI data on the two profiles focalized on SL and to analyze the two contributors groups' characteristics using supplementary variables that can describe their living environment and that can be evaluated for their contribution to the two profiles of attitudes defining the opposite learning orientations on SL subjects.

# 2 Rational and Theoretical background :

The environment of a human individual is a complex tissue of relations with his contemporary world. For each individual it is the representation of what happen in the "the outer side" of the self. It seems rational to think that with the degree of complexity of our scientific culture and the variability of familial and social contexts important variations in the students' vision of their environment will occur based on different experiences memories and representations. Our scientific culture has an unprecedented level of sciences and technology and a world wide organization which leads to unprecedented increases of individuals' interactions with "black-boxes" that might be simple or high technology consumption objects (e.g.: industrialized food; communication gadgets) as much as media advertized issues or ideology (e.g.: global warming; GMO). It has also unprecedented changes and diversifications of the interactions with others human beings in various new situations that can varied with different social or cultural streams of the society which are no more corresponding exactly to the notion of socioeconomic classes. It is essentially with democratic and economical arguments that governments have decided the reforms of sciences curriculums in order that all citizens receive a functional scientific literacy aimed at understanding some aspects of the "black-boxes" created by our sciences and technology and the issues related to it (Ryder, 2001; Robert, 2007).

Therefore the new goal and contents of the science education programs are supposed to be an improvement compared to previous programs shown to be for most students not motivating. They were built to train the successful minority that will pursue in sciences leaving the 90% with useless and obscure memories on disciplinary concepts. However along with our previous works and results on the SL related subjects learning orientations it is clear that motivation to learn on these non disciplinary topics thought as closer to the students is not the fact of everyone. Less than quarter of the students in the French adolescents population have reasoned stable attitudes that will sustain their motivation to learn on SL topics. It is rational to hypothesize that students, although apparently sharing the same everyday world, have rather different living environments experiences. As a consequence it is plausible that learning interest or lack of interest for very specific themes related to sciences, or its relations with the society, might be oriented in the 15 years' old by different understanding and representations of the shared 21$^{st}$ century living environment based on different ways it was presented and occurred to them in various dimensions of this environment during their life.

We have therefore decided to evaluate if the two ASI found profiles which content express students' precise decisions concerning their learning on objects found in the living environment or related to our scientific culture have been reasoned by students who may have particular experiences and representations of the world and of themselves within it.

Each individual experience first the family home environment, then larger social groups to which the family may belong, or that they will encounter at school or in the out-of-school environment. Depending on what he has access to, the individual builds a personal vision of our society and world, of our scientific culture and its impacts on the world. Reaching adolescence, a developmental maturation of the brain changes the way the individual thinks and relates to his living environment and envisages him self in it. The long-term planning or metacognitive abilities, better faculties to consider and interpret others' actions, emotions, or opinions in concomitance with an important desire to socialize are developping self-awareness and autonomy in the decision-making process. This leads to choose and stabilize attitudes and several aspects of the personality (Ernst et al, 2010; OECD, 2001b; Steinberg et al., 2010). The affects involved in the behavioral rules built by the adolescent will have important effects on their attention thus their motivation to learn within the classroom group (Rowe et al, 2006; Gollwitzer & Brandstaetter, 1995). It is therefore essential for a teacher to know about the affects sustaining the learning logic of the adolescents in order to stimulate their expression in the classroom group to reveal the group structure. Such a group approach with adolescents should permit to obtain an overall gain of motivation toward the learning goal proposed to the classroom (Brown, 1998; Wit & Kerr, 2002; Oortwijn, et al., 2008). In our previous work (Montpied et al, 2010) we identified the significant affective learning orientations on sciences related subjects in the French adolescents' population. However the model proposed did not give cues on the origins of such affective orientations.

The origin of the existence in the 15 years old population of two significant subgroups with opposite affects and learning orientations on the objects related to their scientific culture is a major question since these subjects added recently in the sciences curriculums can not find an affective origin in low or high achievement in disciplinary evaluation. It is why we postulate that these previously found adolescents' reasoned system of learning attitudes on SL related subjects founded on the similarities of the students' affects for series of specific subjects may find some origin in living environment personal experiences.

# 3 METHODOLOGY.

## 3.1 Sample and questionnaire

The sample comprises 2124 students from grade 9 and 10 since in France because of the scholar system the 15 years old students can be found in both. These students are from the 126 lower and upper secondary schools classroom withdrawn by the DEPP (Direction de l'évaluation de la Prospective et de Performance du Ministère de l'Education nationale : Department in charge for the education minister to make national statistics on various matters related to the scholar system). The sample contains 53% of girls and 47% of boys.

All these students fully completed the ROSE (Relevance Of Science Education) questionnaire translated in French and supplemented in agreement with the ROSE project with some questions on facts, perceptions, experiences or attitudes informing on home, familial, social, scholar or non scholar students' environments. The French questionnaire (available on http://wwww.ils.uio.no/english/rose) was finalized following a pilot study on a classroom of grade 10 students followed by interviews with some of these students.

## 3.2 Previous data base and finding used in the present work :

The present work, follow some results found in a SIA study of identical sections of the ROSE questionnaire aimed at interrogating the willingness or unwillingness to learn on precise sciences or SL related subjects (Montpied et al 2010). Statistical Implicative Analysis (SIA) of the responses leads to the finding of 17 major cohesitive trees (with an indicator of cohesion (i.c.)> to 0.98) allowing to define a model of the classroom group comprised statistically of the 17 idealtype profiles of attitudes on sciences and SL related subjects corresponding to the cohesitive trees resulting from the contribution of an optimal group of students sharing the same coherent logic on the 109 learning subjects proposed. These idealtype profiles based on a cohesitive structure with the high cohesion and having a logic attesting of a coherent human reasoning express selectively a hierarchy of preferences and of reluctances to learn on related subjects converging toward a sciences or SL theme.

Two of these themes contain most of the subjects proposed in the ROSE questionnaire that are not disciplinary and are relative to transversal matters either on the nature of sciences its history in our culture and mostly sciences and technology issues and applications in our everyday or social life (on the 109 subject of the sections 'What I want to learn about" 33 subjects are transversals and oriented toward sciences and society or culture in relation with progress issues etc ).

The methodology develop is apply to the entire SIA found profiles but we will only study the two profiles of learning orientations relative to the main goal of the new reform. Table 1 resume the data we already have from the primary SIA analysis on the two profiles sustained by optimal groups that should represent statistically two subgroups of the classroom founding the major polarity on the subjects related to SL. In this primary model of the 15 years' old classroom group the 2 learning profiles should help teachers to design the activity and anticipate from the size of the optimal groups in opposition what socio-emotional states they can expect. However at this stage the model is not informing on the possible origin of these orientations and this can be helpful to understand the positions expressed by the students and stimulate cognitive redefinitions of their attitudes which are main aspects for the teachers' leadership efficacy (Brown, 1998).
Appendix 1 shows the structure given by SIA-CHIC software for the P4 profile. The

TABLE 1: MAINS CHARACTERISTICS OF THE TWO OPTIMAL STUDENTS' SUBGROUPS CONTRIBUTING TO THE TWO IDEALTYPE PROFILES OF LEARNING ATTITUDES ON SCIENTIFIC LITERACY RELATED SUBJECTS

| Profiles | Themes |
|---|---|
| **P4**<br>i.c.= 1<br>Optimal grp.=515<br>24% of the national sample<br>Boys = 69.9% (increase p = 0) | *Positive attitudes expressing willingness to learn on:*<br>Nature and history of sciences, the unknown, the controversial issues within the scientists and in the society, the interactions of sciences with our present consequences, applications, very practical aspects in our everyday life |
| **P8**<br>i.c.= 1<br>Optimal grp.=438<br>21% of the national sample<br>Girls = 65.7% (increase $p<10^{-5}$ ) | *Negative attitudes expressing unwillingness to learn on:*<br>Scientists lives and errors, on controversial issues between sciences and society, some sciences inventions or practical applications in our society and questions relative to ecology, farming, food production, energy saving and new energy sources |

## 3.3 Contribution of the students and of living environment supplementary variables to the two profiles of learning attitudes on SL related subjects:

In the ROSE questionnaire many other aspects were interrogated and it is possible to select questions from different sections informing on the individual living environment that we hypothesize as containing factors that might be at the origin of the students logic reflected in the two above profiles of learning orientation SL.

Each question selected was used to define supplementary variables. A question permits to define two types of responses: one representing the upper pole of the Likert scale the other the lower pole. This divides the interrogated population in two subpopulations experiencing differently the aspect of the living environment in question.

Therefore two supplementary variables are defined by each question selected. The contributions of all the supplementary variables to the P4, and P8 profiles are then evaluated using the secondary analysis functionality of the CHIC SIA software (Gras et al;, 2001). It allows to know for each subpopulation defined by the supplementary variable reflecting a trait of the individual living environment:

– the intersection with the optimal group of the two profiles of learning orientation on SL subjects
– the significance for the given profile of this intersection, depending of its size and on the contributive qualities of these particular individuals within the optimal group (see for details and examples Appendix 2).

To select the questions permitting to define the supplementary variables of interest we proceeded along with the fact that any individual experiences and memorizes his living environment roughly in four dimensions relative to the interactions he has with:

- the family and home structures
- the social and cultural world
- the nature and natural world
- the personal space and history.

We made therefore four categories of questions to inform factors related to each dimensions. The ROSE questions selected for this purpose are simple questions on facts which require that students make only a recollection of some experiences, of some memories or representations related to their environment and their interactions with it.

Questions (mostly added in the French version of the ROSE questionnaire) on home material aspects, on parents' relation to sciences will give some information on the above mentioned first dimension of the students' living environment (e.g.: section K: " Me at my family with sciences and technology": .K4: "In my family we are discussing about sciences": do not agree (subpopulation with a trait defining a supplementary variable or agree (subpopulation with the opposite trait defining a second supplementary variable related to the same factor).

The second dimension of the students' living environment encompasses many types of interactions where the individual enter in contact with cultural objects, social structures and social values. In order to have a rather correct appreciation of the effects of factors related to the social dimension of the individual living environment in the learning orientation expressed by the P4 and P8 students' subgroups a broad sample of questions were selected from various sections of the ROSE questionnaire. The "F", "G", "H" sections are used they are designed to inform respectively various students' opinions about sciences at school, about sciences and techniques values in our society, finally various students' activities frequency out-of school.

There are different reasons that lead to our selection. For example students' interactions with traditional objects of our scientific culture (e.g;: thermometer) where opposed with objects of more recent technologies which expansion concern the last 2 or 3 decades (e.g.: cellular phone). Students' interaction with sciences knowledge per se was evaluated in the scholar social structure but also in informal situations: TV or radio or web broadcasting or magazine documentary, museum, games. Students values on sciences and technologies in the modern societies were considered under different angles their general importance, their role in health, in comfort, in politics and economical inequalities, their efficacy to solve problems but also the exactitude of scientists.

The selected questions to assess the third dimension concerning the representations of nature or natural world in our living environment, are interrogating the students on their effective contact with nature (e.g.: planted seeds, watching an animal giving birth, collecting fruits etc) and on their intellectual contact with various opinions largely diffused about nature and human or individuals responsibilities concerning it (e.g.: " threat to environment are not my business" "nearly all human activity is damaging for the environment"). Finally related to these different contacts the question H24 attesting or not of an effective ecological action: "sorting garbage for recycling".

The questions selected to assess the personal dimension of the living environment that take place in individual life time interaction with the world leading to representation of the self in his relation to the present and future living environment, are from the sections J and L added in the French ROSE questionnaire and some are from the "D", the "F", the "H" section as well as from the "B" section on the students' projection in his future social life.

This fourth dimension of our assessment of factors and traits relative to the living environment consists in the selection of some questions implying the expression of personal inner thoughts, incentives or beliefs, self esteem, self commitments that lead the individual to adopt personal behaviors or choices in his interactions with the environment. This decision lays in the fact that at age 15 the individuals have reach a developmental stage permitting to consider they have acquired maturity that enable them to drive their decisions and behaviors in congruence with internal plans, long term goals, wills, or religion etc (see OECD, 2001; Steinberg, 2010).These internal representations built on life experiences in their environment become stable constructs and are somewhat independent of the immediate time since adolescents have acquired autonomy and personalities. The questions selected to built supplementary variables corresponding to the traits reflecting these personal aspects are referring to miscellaneous elements and are picked in various sections of the ROSE questionnaire: mostly the J and L added in the French ROSE questionnaire and some are from the "D", the "F", the "H" section as well as from the "B" section reflecting the students' projection in his future social life. The selected questions will inform about the representation the students have of themselves in interaction in present or future situations (e.g.: sciences problem at school, scientific or natural objects in everyday life, sciences related aspects of a future job etc), leading to specific interactions and behaviors of the students in his environment that are not depending (at least directly) of an adult and or a cultural intervention or imitation. This means for example that an activity as: *"opening up a radio, a clock, or other devices to understand how it work"* is a spontaneous interactions with an everyday object of home environment driven by personal curiosity whereas in comparison *"collecting edible berries, fruits, mushrooms or plants""* (classified in direct contact with natural world) is a standard cultural activity to which certain students are brought to participate in their socio-familial environment and group. Similarly for other types of engagements this means that stating something as *"If I do not understand something in sciences I search for more information"* is reporting a personal action on which the students has control whereas stating something on the scholar taught sciences is only a conclusion on obligatory experiences in the socio-cultural living environment imposing the participation to this scholar institution. All the statements made will inform students' traits related to the representation the students have of themselves in interaction in present or future situations (e.g.: sciences problem at school, scientific or natural objects in everyday life, sciences related aspects of a future job etc).

As explained in the Appendix 2 we have calculated for each trait defined by a supplementary variable and relative to the students living environment: the percentage of students expressing a given trait in the optimal group sustaining the P4 and P8 profiles and if observed the significance of the increase of such a trait.(CHIC software; Gras et al 2001). These data reported in the results tables.

# 4 RESULTS.

The results we obtained from the contribution analyses of the supplementary variables built from the selected items of ROSE questionnaire are presented in the following in four sections. Secondary to the SIA made on the French 15 years old students' learning orientations toward sciences related subjects, the results of these contribution analyses will only concern to profiles called P4 and P8 expressing respectively willingness and unwillingness to learn on subjects important in the development of their scientific literacy (see methodology Table).

Each section treats of the results obtained with a category of supplementary variables corresponding to students' representations, perceptions, interactions or self projections in one of the four main living environment dimensions that can be described for any human individual (see methodology section).

We found many traits in relation to sciences or scientific aspects occurring in the four individuals' living environment dimensions that differentiate the students of the P4 and P8 optimal groups. The results globally suggest that these students' traits might be involved in the students' reasoning of the two opposite idealtype learning orientation on scientific literacy related subjects.

## 4.1 Traits informed by supplementary variables built from students' responses on their home and familial living environment

Home and family traits reported in Table 2 correspond to students answers to questions where this environment is interrogated *"as an environment where people have relations with sciences*" (i.e.: parents job on parents interest in science), *"as an environment rich in hitec goods for general comfort, for leisure, for communication"* (i.e.: number of TV, on the internet connection, cars etc) and *"as an environment spacious and wealthy, quiet with cultural and educational supplies"* (i.e.: number of bathroom, a quiet place to work, having books to do the home work, number of book at home). The secondary analyses of the supplementary variables built on the students answers permit to compare the contribution of these traits to the learning orientations of the two optimal students' subgroups contributing to the P4 and P8 profiles expressing willingness and unwillingness to develop their scientific literacy.

It shows that parental orientation toward sciences is a major factor in students' learning orientation on scientific literacy topics (see table 2 item K1 and K3 with opposite balances between the P4 and P8 optimal group of contributors for the agreeing and disagreeing subpopulations). Concerning the material goods and home aspects we observed that he number of books is the only material aspect that interferes with the students 'learning orientations on scientific literacy subjects and it does in a much lesser extent than the human parental factor. The presence of a dictionary and of books to work is not differentiating the two subgroups of students because it is almost all students have these facilities (data not shown).

TABLE 2 - EXPRESSION OF TRAITS RELATIVE TO THE FAMILIAL AND HOME ENVIRONMENT

LEGEND: * 0.1 < P<0.01 ; ** $10^{-3}$ <P< $10^{-5}$ ; *** $10^{-6}$ < P< $10^{-8}$- † $10^{-9}$ < P< $10^{-14}$, † † > $10^{-14}$

| **Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects:** | **% in nation group** | **% in P4 sub-group** | **% in P8 sub-group** |
|---|---|---|---|
| ***Familial and Home environment*:** | | | |
| *Material potentials* | | | |
| J :"There is less than 50 books at home" | 31% | 20% | **43%** *** |
| "There is more than 50 books at home" | 68% | **79%** *** | 56% |
| K17: "there is no computer at home" | 3% | 2.3% | 2.5% |
| "there is one computer at home" | 41% | 37% | 43% |
| "there are more than one computer" | 55% | 61% * | 52.5% |
| K06: "there is one internet connection at home" | 89% | 90% | 89% |
| *Human interactions or exchanges concerning sciences:* | | | |
| K1: " My parents like to know what my sciences classes were about" | | | |
| Agree | 39% | **50%** † | 27.5% |
| Disagree | 52% | 42% | **66.5%** *** |
| K2: "My parents are particularly happy when I succeed in sciences" | | | |
| Agree | 67% | 71%* | 60.5% |
| Disagree | 26% | 22% | 33%** |
| K3: "My parents are interested in sciences (reports on TV, radio magazines)" | | | |
| Agree | 54% | **65%** *** | 40% |
| Disagree | 37% | 26% | **54%†** |
| K4: "In my family we are discussing about sciences" | | | |
| Agree | 67% | 41% | 12% |
| Disagree | 25% | 51%† † | 82%*** |
| K5: "My parents have a job in relation to science" | | | |
| Agree | 20% | **27%** ** | 13.6% |
| Disagree | 75% | 68% | **81.5%** ** |

## 4.2 Traits informed by supplementary variables built from students' responses on their social and cultural environment

Similarly, to evaluate if interactions with general aspects of our 21rst century society and scientific culture might have influenced the students learning orientations on science literacy related subjects, we analyzed their responses about their experiences or perceptions with objects or activities or rather common opinions about sciences that are easily encountered in our scientific culture.

The first traits, reported in Table 3a, correspond to the students' answers to questions interrogating effective interactions or lack of those with either traditional objects of our scientific culture (e.g.: road map, thermometer etc) or more generational ones (e.g.: cell phones, computers). Clearly it is for the expression of traits characterizing the interactions with traditional objects non specific of the generation that we observe significant differences between the national proportion of these traits and the proportions seen in the two optimal subgroups sustaining either the positive (P4) or the negative (P8) learning orientation on SL. The traits characterizing interaction with objects more specific of the generation show none or small differences between the two students' subgroups. Only one interactive object specified in the item: H48 of the ROSE questionnaire (see Table 3a) permits to see that the use of encyclopedia or dictionary on a computer (an Hitec object present in almost all home see Table 2 item K06) is a trait increased in the P4 optimal group whereas the lack of use for this "object" is increased in the P8 optimal group compared to the average expression of these two traits in the national population.

TABLE 3 A - *EXPRESSION OF TRAITS RELATIVE TO THE SOCIAL AND CULTURAL ENVIRONMENT.* EFFECTIVE INTERACTION OF THE STUDENTS WITH SCIENTIFIC AND TECHNICAL OBJECTS OF THE 21RST CENTURY SCIENTIFIC CULTURE:

LEGEND: * 0.1 < P<0.01 ; ** $10^{-3}$ < P < $10^{-5}$ ; *** $10^{-6}$ < P< $10^{-8}$- † $10^{-9}$ < P< $10^{-14}$, † † > $10^{-14}$

| **Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects:** | **% in nation group** | **% in P4 sub-group** | **% in P8 sub-group** |
|---|---|---|---|
| H3 "Read a map to find my way" | | | |
| Never | 17% | 12% | **23% **** |
| Often | 19% | **28% ***** | 11.5% |
| H41:" used a stopwatch" | | | |
| Never | 8% | 4.7% | **13% ***** |
| Often | 28% | **37.5% ***** | 20% |
| H42 " "measured the temperature with a thermometer" | | | |
| Never | 10% | 6.6% | **18% †** |
| Often | 31% | **43% †** | 21% |
| H38: "Recorded on video, DVD, or tape recorder" | | | |
| Never | 6% | 2.7% | **9.3%**** |
| Often | 47% | **54% **** | 42% |
| H39: "changed or fixed electric bulbs or fuse" | | | |
| Never | 24% | 15.3% | **33%***** |
| Often | 20% | **31% †** | 13% |
| H45: "sent or received a SMS" | | | |
| Never | 4% | 3.9% | 3.9% |
| Often | 77% | 77% | 79% |
| H46: "Searched the internet for information" | | | |
| Never | 2% | 1% | 3%* |
| Often | 77% | 83%* | 72% |
| H47: "Played computer games" | | | |
| Never | 3% | 1.1% | 4.5%* |
| Often | 65% | 74%** | 60% |
| H48: "Used a dictionary, encyclopaedia etc. on a computer | | | |
| Never | 8% | 4.3% | 13%** |
| Often | 40% | 49%** | 29% |
| H49: " download music from the net" | | | |
| Never | 13% | 13.4% | 12% |
| Often | 55% | 59%* | 53.5% |
| H50: " sent or received e mail" | | | |
| Never | 6% | 5.2% | 7.5%* |
| Often | 63% | 67.5%* | 60.5% |

Since in our modern society with extended scientific knowledge children receive obligatory science education at school one of the first social structure they integrate and may also receive this knowledge in informal and non obligatory situations, we postulate that all the students may not have the same levels of interaction with sciences knowledge in both types of social environment.

On Table 3b we can see that our analyses show clearly that the P4 subgroup of students presents a significantly higher number of students expressing the traits concerning the out-of-school contact with scientific knowledge whereas in contrast the P8 subgroup presents a lower number of those compared to the national sample group and consequently compared to the P4 subgroup. In addition it is quite interesting to put in relation the results obtained on two items F2 and F12 about taught sciences at school. For the P4 students optimal group the proportions of students finding it interesting is significantly increased and the proportions of students finding that these taught sciences have shown them the importance of sciences in their way of living is similarly increased. The totally reversed picture is seen for the traits expressed in the P8 optimal group.

TABLE 3 B - EXPRESSION OF TRAITS RELATIVE TO THE SOCIAL AND CULTURAL ENVIRONMENT EFFECTIVE INTERACTION WITH SCIENCES KNOWLEDGE IN FORMAL OR INFORMAL CONTEXTS OF THE SOCIETY:

LEGEND: * 0.1 < P<0.01 ; ** $10^{-3}$ < P < $10^{-5}$ ; *** $10^{-6}$ < P< $10^{-8}$- † $10^{-9}$ < P< $10^{-14}$, † † > $10^{-14}$

| Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects: | % in nation group | % in P4 sub-group | % in P8 sub-group |
|---|---|---|---|
| F1: "School science is a difficult subject" | | | |
| Agree | 53% | 40% | 60%* |
| Disagree | 41% | 54%*** | 34.5% |
| F2: "School science is interesting" | | | |
| Agree | 66% | 83% † | 47% |
| Disagree | 27% | 10.3% | 44%†† |
| F3: "School science is rather easy for me to learn" | | | |
| Agree | 35% | 48%*** | 27% |
| Disagree | 58% | 44% | 66%** |
| F5: "The thing I learn in science at school will be helpful in my everyday life" | | | |
| Agree | 34% | 52% †† | 22.5% |
| Disagree | 59% | 42% | 72.5%** |
| F12:" School science has shown me the importance of science in our way of living" | | | |
| Agree | 49% | 69% † | 28% |
| Disagree | 40% | 24% | 61%†† |
| H9: "Visited a science centre or science museum" | | | |
| Never | 30% | 17% | 44% † |
| Often | 8% | 16% †† | 2.5% |
| H12 " read about nature or sciences in books or magazines" | | | |
| Never | 26% | 14% | 48%†† |
| Often | 16% | 27% †† | 4.3% |
| H13 " Watched nature programmes on TV or in a cinema" | | | |
| Never | 20% | 9.7% | 35.5% †† |
| Often | 18% | 27% †† | 8.2% |
| H36: " Used a science kit (like for chemistry, optic, or electricity) | | | |
| Never | 55% | 38% | 73.5% † |
| Often | 5% | 10% † | 1.8% |

In the last part of our investigation using supplementary variables reflecting interaction with social structure or values (Table 3 c) we evaluate traits concerning the students' engagement on common opinion about the role of sciences in a society. We can observe consistently an increase in the proportions of students expressing negativity on sciences roles in the society in the P8 subgroup whereas the reverse is observe in the P4 subgroup.

TABLE 3C - EXPRESSION OF TRAITS RELATIVE TO THE SOCIAL AND CULTURAL ENVIRONMENT INTERACTION WITH OPINIONS FREQUENTLY HEARD ON SCIENCES AND TECHNOLOGIES IN OUR SCIENTIFIC CULTURE:

LEGEND: * $0.1 < p < 0.01$ ; ** $10^{-3} < p < 10^{-5}$ ; *** $10^{-6} < p < 10^{-8}$ - † $10^{-9} < p < 10^{-14}$, † † $> 10^{-14}$

| Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects: | % in nation group | % in P4 sub-group | % in P8 sub-group |
|---|---|---|---|
| G1: "Science and technology are important for society" | | | |
| Agree | 74% | 89% *** | 57.5% |
| Disagree | 18% | 6% | 34.5% †† |
| G4: "Sciences and technologies makes our life healthier, easier and more comfortable" | | | |
| Agree | 60% | 73% *** | 46% |
| Disagree | 29% | 20% | 42% *** |
| G12: "science and technology benefit mainly the developed countries | | | |
| Agree | 64% | 76% ** | 48% |
| Disagree | 23% | 15% | 36% † |
| G13: "Scientists follow the scientific method that always leads them to correct answers" | | | |
| Agree | 22% | 32% *** | 17.5% |
| Disagree | 60% | 56% | 64%* |
| G8: " Science and technology can solve nearly all problems" | | | |
| Agree | 21% | 32% † | 17% |
| Disagree | 68% | 61% | 74.5% * |

## 4.3 Traits informed by supplementary variables built from students' responses on nature or natural aspects in their living environment

The dimension of the living environment relative to representation of what is the "nature" or the "natural world and phenomena" and what should be done for it, did appear to us as containing potentially some traits that might discriminate the two subgroups of students sustaining the idealtype profiles expressing willingness or unwillingness to develop their sciences literacy. This idea was sustained by the fact that several subjects proposed as learning targets and selected by the students of the two optimal groups are related to ecological issues and nowadays world challenges.

Concerning these students' traits characterizing their interactions with various aspects of the natural world (see Table 4), a striking feature appears in the optimal subgroup contributing to the P8 idealtype profile: consistently the proportions of students expressing the lack of interactions with the natural aspects proposed in the ROSE questionnaire items are highly increased compared to the proportions in the national sample. This is not observed for any items in the P4 optimal subgroup. In contrast most of the time there is a slight decrease of such traits and a noticeable increase of the students expressing the opposite trait meaning that in the P4 optimal subgroup the balance between students lacking of experiences in the natural world and those having such experiences is highly different from the balance seen in the national sample and of course in the optimal subgroup contributing to the P8 profile. This should have important consequence in representation of phenomena and understanding of the teachers' discourses relative to these elements in particular in life science under the thematic of the new programs "planetary challenges today".

Concerning the opinions on the environmental issues fairly spread and common in our society, we observe significant differences between the students contributing to the P4 and P8 idealtype profiles. The alterations in the proportions of students' expressing certain of these traits are however not as striking as those observed on the traits related to the students' direct experiences with the natural world.

Globally, the results obtained on the traits relative to this dimension of the living environment experienced by the students gives the sense that the students contributing to the P4 profile who have far more experiences with natural world events or objects having consequently concrete memories and representations of it, are aware of the effect of men on the nature, have confidence in sciences to solve such problem. Altogether the results suggest that they have knowledge which gives them a readiness to learn on these matters which most probably plays in their learning orientations toward sciences in relation to the world and the society. In contrast the students belonging to the P8 optimal subgroup will be frequently lacking such memories and representations which may alter their possibilities to have some positive affects for learning on subjects that integrate sciences, the society and the world challenges and globally alter their readiness to develop their scientific literacy.

TABLE 4 - EXPRESSION OF TRAITS RELATIVE TO THE NATURAL WORLD ENVIRONMENT. EFFECTIVE INTERACTIONS WITH THE NATURAL ENVIRONMENT AND INTERACTIONS WITH OPINIONS FREQUENTLY HEARD OF CONCERNING NATURAL ENVIRONMENT ISSUES.

LEGEND: * 0.1 < P<0.01 ; ** $10^{-3}$ < P < $10^{-5}$ ; *** $10^{-6}$ < P< $10^{-8}$- † $10^{-9}$ < P< $10^{-14}$, † † > $10^{-14}$

| | % in nation Group | % in P4 sub-group | % in P8 sub-group |
|---|---|---|---|
| H1: "Try to find the constellation in the sky": | | | |
| Never | 42% | 32% | **59.5% †** |
| Often | 11% | 15% ** | 5.2% |
| H5:" Collected different stones and shells" | | | |
| Never | 12% | 11% | **23% ††** |
| Often | 21% | 25% * | 11.5% |
| H6: "Watch an animal being born (not on TV) | | | |
| Never | 51% | 47% | **57% **** |
| Often | 8% | 10% * | 7% |
| H7: "Cared for animals on a farm" | | | |
| Never | 42% | 38% | **52% **** |
| Often | 13% | 14% | 10.5% |
| H10: "milked animals like cows sheep or goats" | | | |
| Never | 63% | 60% | 70% * |
| Often | 5% | 5.6% | 3.6% |
| H14: "Collected edible berries, fruits, mushrooms or plants" | | | |
| Never | 22% | 18% | **38% †** |
| Often | 20% | **27% **** | 11% |
| H17: "Planted seeds and watched them grow" | | | |
| Never | 32% | 26% | **50% †** |
| often | 10% | **13% **** | 5.9% |
| H18 "Made compost of grass, leaves or garbage" | | | |
| Never | 60% | 56% | **78% ***** |
| Often | 9% | **14% ***** | 3.6% |
| H22: "Made a fire from charcoal or wood" | | | |
| Never | 21% | 16% | **30% ***** |
| Often | 27% | **37% ***** | 18% |
| H24 "sorted garbage for recycling or for appropriate disposal" | | | |
| Never | 21% | 10% | **29.5% ***** |
| Often | 32% | **42% **** | 25% |
| D01," Threats to the environment are not my business" | | | |
| Agree | 11% | 8.3% | 16% ** |
| Disagree | 85% | 90% * | 79% |
| D04: "Sciences & technologies can solve all the environmental problems" | | | |
| Agree | 27% | **38% ***** | 20% |
| Disagree | 62% | 54.5% | 69% * |
| D11: "It is the responsibility of the rich countries to solve the environmental problems of the world" | | | |
| Agree | 39% | 45.5% ** | 32% |
| Disagree | 50% | 46.5% | 56% * |
| D13: "Environmental problems should be left to the experts" | | | |
| Agree | 20% | 17% | 26% ** |
| Disagree | 71% | 78.5% * | 65% |
| D17: " Nearly all human activity is damaging for the environment" | | | |
| Agree | 48% | 53% * | 43% |
| Disagree | 39% | 39% | 44% * |

## 4.4 Traits informed by supplementary variables built from students' responses on personal inner constructs based on personal history in the living environment

As reported in Table 5 a, most of the traits defined from the responses on the items more representative of internal disposition driving typical behaviors in front of objects that have a scientific content, are showing quite significant differences of expressions levels in the P4 and P8 optimal group of students. We observe in particular that spontaneous curiosity about the inside mechanisms of everyday devices is a trait more expressed in the students willing to develop their scientific literacy. Their spontaneous search for links between what they learn in sciences and other disciplines seems also more affirmed (compared to national sample and in much larger extent compared to the P8 students).

The optimal group of students contributing to the profile P8 expressing unwillingness to develop their scientific literacy is characterized by its increases in the proportion of students who are not putting any values on sciences knowledge or technology in the present and the future. The most characteristic trend of the students from the P8 optimal group is the increase in students that feel not valorized by good mark in science. For most statements on sciences, techniques, attraction for jobs and matters related to it the two optimal groups of students behave in opposite directions: the P4 students tend to be attracted by such aspects the P8 students tend to reject the same aspects.

In addition it seems that the two subgroups contributing either to the P4 idealtype profile or to the P8 one have opposite tendencies concerning the engagement as citizens toward planetary challenges and protection of the nature (e.g.: willing to make sacrifice to solve environmental problem) or concerning the almost religious statement related to these aspects (e.g..: thinking nature is sacred and should be left in peace).

TABLE 5A- EXPRESSION OF TRAITS RELATIVE TO PERSONAL SUBJECTIVE ENVIRONMENT PERSONAL STATEMENTS INDICATING INTERNAL CONFIDENCE (OR LACK OF IT) IN THE ABILITY TO COMPREHEND THE SURROUNDING SCIENTIFIC KNOWLEDGE.

LEGEND: * 0.1 < P<0.01 ; ** $10^{-3}$ < P < $10^{-5}$ ; *** $10^{-6}$ < P< $10^{-8}$- † $10^{-9}$ < P< $10^{-14}$, † † > $10^{-14}$

| **Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects:** | **% in nation group** | **% in P4 sub-group** | **% in P8 sub-group** |
|---|---|---|---|
| H52: "Opened a device ( radio, watch, computer, telephone, etc) to find out how it works" | | | |
| Never | 21% | 15% | **35% †** |
| Often | 30% | **41% ***** | 20% |
| L2: " Even when I have good marks in sciences I do not believe I **understand something**" | | | |
| Agree | 35% | 30% | 38%* |
| Disagree | 58% | 65%** | 58% |
| L5 "I **have personal knowledge** in sciences that allows me to be better" | | | |
| Agree | 29% | **41% †** | 20.5% |
| Disagree | 60% | 47% | **70.5%**** |
| J3 " If I do not **understand something** in sciences I search for more information" | | | |
| Agree | 54% | **69% ***** | 38% |
| Disagree | 37% | 25% | **53%†** |
| J7 "When I learn in science I **make links with** what I learnt in other disciplines" | | | |
| Agree | 49% | **69% †** | 33% |
| Disagree | 39% | 22% | **56%†** |

TABLE 5 B- EXPRESSION OF TRAITS RELATIVE TO PERSONAL SUBJECTIVE ENVIRONMENT SELF REPRESENTATION, PERSONAL CONVICTIONS RELIGIOUS THINKING IN THE PRESENT AND FUTURE PROJECTIONS.

LEGEND: * $0.1 < p < 0.01$ ; ** $10^{-3} < p < 10^{-5}$ ; *** $10^{-6} < p < 10^{-8}$ - † $10^{-9} < p < 10^{-14}$, † † $> 10^{-14}$

| **Items tested as indicators of potential factors involved in the learning orientation toward scientific literacy related subjects:** | **% in nation group** | **% in P4 sub-group** | **% in P8 sub-group** |
|---|---|---|---|
| L1: "I am **valorized** by my good **marks** in sciences" | | | |
| Agree | 63% | **74%** ** | 49% |
| Disagree | 30% | 20% | **43.5% †** |
| L4: "**Succeeding** in sciences is a question of **chance**" | | | |
| Agree | 17% | 14% | 21%* |
| Disagree | 76% | 83%* | 72% |
| L6: "I **feel totally disoriented** when I have to solve a science | | | |
| problem" | | | |
| Agree | 26% | 21% | 26% |
| Disagree | 63% | 72%** | 69% |
| L7 "Whenever I **decide it I can** solve the more complex problem in | | | |
| sciences" | 58% | **72%*** | 45.5% |
| Agree | 30% | 18% | **42.5%*** |
| Disagree | | | |
| L8 "I am very **nervous about my success** to perform in sciences | | | |
| tasks, exercises, evaluative tests etc." | | | 33% |
| Agree | 37% | 37% | 55%* |
| Disagree | 51% | 55%* | |
| D18:" The natural world is sacred and should be left in peace" | | | |
| (personal religion) | | | 72% |
| Agree | 78% | 81% * | 16% ** |
| Disagree | 11% | 9.5% | |
| D05 "I am willing to have environmental problems solved even if this | | | |
| means sacrificing many goods" | | | 58% |
| Agree | 70% | 81% ** | **30%** *** |
| Disagree | 20% | 13% | |
| B4:" In my future job or occupation it is important to work on the | | | |
| environment protection " | | | |
| Agree | | | 50% |
| Disagree | 63% | 72% ** | **46% †** |
| B6:" In my future job or occupation it is important to build or repair | 30% | 23% | |
| objects with my hands " | | | |
| Agree | | | 38% |
| Disagree | 48% | 57% ** | **57%** *** |
| B7:" In my future job or occupation it is important to work with | 44% | 31% | |
| machines or tools" | | | |
| Agree | | | 31% |
| Disagree | 44% | **58% †** | **63%** *** |
| B11 :" In my future job or occupation it is important to come up with | 48% | 36% | |
| new ideas " | | | |
| Agree | | | 66% |
| Disagree | 77% | 89% ** | **28%** *** |
| F14: "I would like to be a scientist" | 19% | 10.5 | |
| Agree | | | 11.5% |
| Disagree | 23% | **39% ††** | **82%** *** |
| F16:" I would like to get a job in technology" | 67% | 50% | |
| Agree | | | 17% |
| Disagree | 32% | **55% ††** | **77% †** |
| | 58% | 36% | |

# 5 DISCUSSION.

The education and development in all the future citizens of a minimal functional scientific literacy which is required to be engaged in the evolution of our scientific culture has been envisaged in the French reforms of sciences curriculums. We showed previously using SIA on a large national sample and a large listing of sciences related subjects that there are depending of the school 15 to 39% of the 15 years' old students with reasoned willingness to develop their scientific literacy and 18 to 30% with the opposite reasoning (Montpied et al., 2010). In the particular case of these two idealtypes profiles relative to scientific literacy learning (P4 and P8 profiles), the subjects linked by a similarity of reasoning are transversal and should not be conceived by the students as related to traditional conceptual learning in a given science discipline and to memory of failure or achievement in this discipline. The lack of motivation to learn on subjects related to the future citizen life and to everyday life is thus a new and concerning problem of motivation to learn in sciences classes that teachers will have to solve whereas they have not yet solve the problem of adolescent students' motivation to learn on the traditional content of sciences curriculum (Veder-Weiss & Fortus, 2011).

The aim of the initial work using SIA was to found a model of the main idealtype subgroups in the classroom group with opposite or different learning orientations on sciences and scientific literacy related subjects. Because the main expectation of the reform is the development of a functional scientific literacy useful to all citizens and the development of positive attitudes on sciences and technologies in the society we focus our attention in the present work on the two students' subgroups sustaining the idealtypes learning orientations expressing for one subgroup willingness and for the other unwillingness to develop scientific literacy about their scientific culture. Our purpose was to pursue the model of the classroom group built to help the teachers to envisage the learning dynamic on a given theme or subjects by giving more information on the students' subgroup sustaining these idealtype learning orientations. To do so we introduce supplementary variables informing on potential factors that could have lead the students of each optimal group to reason the idealtype learning orientation they contribute to.

Our results bring elements to sustain the postulate made that the affective learning orientations toward or away from the subjects related to science in our society originate at least in part in the individual living environment (see section rational and theoretical frame). In addition we demonstrate that the use of SIA secondary analyses of the contribution of supplementary variables built on the appropriate students' responses informs on traits suitable to complement the initial model. Through this approach we can now give to the teachers descriptive aspects of the two idealtype profiles attitudinal structures and contents with the national average sizes of the two significant subgroups contributing to these profiles but also descriptive aspects concerning the optimal group contributing to the profile P4 and P8.

We found by using a broad range of students' responses given in the ROSE questionnaire informing on traits relative to their living environment that each optimal group contributing to the profile P4 and P8 have significant trends to express some traits allowing to characterize each group and to propose some possible origin to the distinct learning orientation on subjects that should promote some interest in the future citizen. The supplementary variables built to inform traits related to the **familial and home**

**living environment (table 2)** show that the nature of home material enrichment and not their cost change their relation to the P4 and P8 students' engagement or disengagement in learning on social matters related to sciences. We evaluate diverse responses on home material goods to define traits relative to this first dimension of the living environment and found that some of these traits can only be use as a referential in our research of factors playing in a particular learning orientation toward sciences literacy related subjects since almost all the students report that they have at home one computer (96%), an internet connection (89%), one or more cellular phone (98.2% data not shown). These data are consistent with the persistent increases in the recent years of the digital life and its expansion in all social classes and in the teenagers group. Other material aspects more related to comfort ere investigated (data not shown) but rather similarly are not showing any differences between the two students' subgroups contributing to the P4 and P8 profiles.

In contrast the traits informing on a low and a high number of books present at home are those showing the most significant difference in their level of expression between the P4 and P8 optimal group. We categorize the responses on this material aspect using only the extreme threshold of 50 books under which we thought that the responses on the number of books at home could be used as an indicator of the socio-economic status and social class along with the previous reports on the fact that libraries are not visited by lower classes (Marks, 1999). However, we can see that the P8 students are probably more frequently than the national average living in a social class with lower socio-economic status but most of them can afford TV, cellular phones, computer, and internet connection. It seems thus that the P8 learning orientation occurs more in students' belonging to a socio-cultural stream where books are not considered as alternative media of information or divertissement compared to TV, or internet. Such familial context does not seem to be exactly marked by economic problem. In the subpopulation of students living in this familial context (representing 31 % of the national population) there are about 28 % of the students who reason the P8 negative learning attitudes on sciences and social, cultural or everyday matters and only 15% who reason the P4 positive attitudes on the same aspects.

In comparison the human relations and exchanges informed by traits relative to parental implications with their child and sciences show that it is the traits expressed by the subpopulations of students reporting that in their family they are discussing or not about sciences that differentiate the most between the P4 and P8 subgroups. The national students' subpopulation saying that in their family they are discussing of sciences matters is only representing 25% of the population. This represents thus an other socio-cultural stream and in this one there are 63% of the students who reason consistently positive attitudes on sciences and social, cultural or everyday matters (P4 profile) and only 32% of students who are reasoning the P8 logics of negative learning attitudes on the same aspects.

From these first analyses permitted by the SIA and the study on the supplementary variables contribution we can conclude that the presence or the absence of books at home correlate with living conditions leading to representations and relations with our culture that have an impact on the attraction toward the scientific literacy subjects. Nevertheless the main factor in this dimension of the students' living environment is relational leading most probably to representations of the adult as reacting, exchanging and knowing about science facts surrounding them.

In coherence with the results on the primary home and familial “envelop” of the individual environment we found that the secondary analyses of the supplementary variables defining traits that we relate to interactions occurring beyond home and familial space across social or cultural activities (Table 3, a, b, c) show clearly that the two subgroups sustaining the opposite learning orientations on SL related subjects have totally different experiences with objects of our culture and society and in structures those are offering.

In analogy with the difference of impact of material factors as books compared to computers we found that the factors defined by the effective interactions with science related objects or phenomena have quite different impact on the P4 and P8 learning orientations based on their nature. For example in the P4 optimal group the percentage of students reporting they frequently interact with the traditional objects (e.g.: reading a roadmap, taking a measure with a thermometer etc) is higher that in the average population and much higher than in the P8 optimal group. In comparison the interaction with objects typical of our century (e.g.: playing computer game, searching information on internet etc.) are not showing much difference. Nevertheless we see that using tools in the computer as encyclopedia or dictionary is a trait found more expressed among the students of the P4 idealtype whereas the lack of use of such tool is increased among the students of the P8 idealtype.

However in the study of the traits relative to the social and cultural environment the more striking results were found in formal or informal sciences learning situations where the students of each optimal group contributing thus either to the P4 positive or to the P8 negative orientation toward SL related topics have not at all the same level of experiences.

In their scholar life the French 15 years ‘old are a majority to say that taught sciences is a difficult discipline but they are also 66% to admit it is interesting and only 27% thinking it is not. Among the last 27%, one third are contributors to the P8 idealtype whereas less than one tenth contributes to the P4 idealtype learning orientation. Most contributors to the P4 idealtype profile of positive learning attitudes toward scientific literacy related subjects think taught sciences interesting (83%) and many of them seem satisfied by scholar teaching of the relation of sciences with our way of life (69%). Such representations of taught sciences are concerning much less students in the subgroup contributing to the P8 idealtype profile and in contrast the frequency of students finding taught sciences not interesting is high (44%) in these students who are also saying that scholar teaching did not show them the relation of sciences with our way of life (61%).

These statements show all highly significant differences compared to the average population and they are of all the supplementary variables testes in our secondary analysis of traits those that are showing the highest difference between the two optimal groups expression levels. This is thus quite fundamental and informs us that scholar science teaching perception has something to do with these orientations on the desire of becoming a scientific literate person. It means that science teachers should investigate the initial a priori of their students and take care of this diversity to operate some cognitive redefinition of such attitudes that might have unfortunate consequences for the future citizen functional scientific literacy. This also questions two years after the beginning of the reform the teachers' efficacy in their effort to interest and develop scientific literacy in all students.

By cumulating the results we obtained on the two "envelop" of the individual living environment, we can see that there are significant tendencies to express some traits in the students belonging to the P4 versus the P8 optimal group. This suggests that there is a "P4 type" versus a "P8 type" of living environment that changes the attraction toward the development of a citizen functional scientific competence in relation to our culture. The characteristics of each may be highly related to familial contexts one where educational and literacy values lead to direct or indirect stimulation of the willingness to become a sciences literate person the other where such incentives are not appearing. This means that teacher needs to act in function of this diversity to reach the new reform goal in all the members of their classroom (Lee & Luykx, 2006; Clark, 2000).

Considering that many adolescents are impregnated with an urban culture (most of them living in urban areas) and that it is a fact rather transversal existing in the different socio-economic or socio-cultural subgroups of the population it was not in these views and interactions with the natural world expressed by the 15 years' old students that we did expect the most striking difference between the students contributing to the P4 and P8 profiles. It is nevertheless in these supplementary variables corresponding to the traits describing effective interactions with natural objects that we found among the highest significant differences between the two students' optimal groups. The most striking differences concern simple activities as collecting some stones or shells and as planting seeds to watch them grow. Both activities are frequently proposed in elementary schools and in more informal educational contexts and in spite of that too many students reach age 15 with no experience or recollection of doing these actions and one third of these students express the steady unwillingness to learn on sciences, society and planetary challenges corresponding to the P8 profiles.

An item relative to making compost from grass and leaves shows also that the two opposite traits defined by the frequency of this activity have highly different levels of expression among the P4 and P8 optimal subgroups.

For these three items relative to experiences leading to students' consciousness of non animal natural elements the implication of adults educational actions are in general required. It is possible therefore that the significant differences between the P4 and P8 optimal group concerning the interactions with nature is occurring as a consequence of the same process mentioned for the students' experiences in the two prior dimensions of the living environment, meaning familial socio-economic or socio-cultural contexts where such interactions are (or are not) possible or encouraged. Only 12% of the adolescents never collected stones and only 9% have made compost often and these students' minorities originate most probably from marginal cultural or socio-economical grounds. Never being exposed to situation where it is possible to collect stones or shells seems to reveal an extreme poverty of the educative experiences that may be the fact in some classes with low education level. In any case 39.5 % of the adolescents saying they never have such activity with stones and shells are belonging to the optimal group contributing to the P8 profile expressing no desire to learn on sciences in relation to society or the world. In contrast making compost requires being surrounded by adults willing to use natural fertilizers thus having some engagement in learning some ecological principles but also who are having the possibility to exert this which requires access to a place as a garden. This means that the students saying they often participate to such activity belong to a micro-cultural group where this access and the participation to the gardening are possible. Among these students 38% are belonging to the optimal group contributing to the P4 profile expressing a desire to learn on sciences and society issues.

At this stage of our discussion it is important to observe that the students' learning orientation on scientific literacy subjects are probably due to many interacting factors material and spiritual that lead to a diversity of prior knowledge built on experiences and interactions with closely related human and natural or material environment. It suggests that main stream and the micro-cultural streams existing in our society are at the origin of the differences in learning desire on sciences in relation to society or world challenges. The problem of the students microcultural diversity has been studied for several decades in particular in US and UK following the sciences for all project and has been described as both a major difficulty to perform science education (Lee & Luykx, 2006) but also a potential richness in a group (Clark, 2000). It seems thus essential that the teachers do recognize that to reach all the students they have to respect the social and cultural diversity of the population represented in their classroom group. Our model is now permitting not only to envisage polarities and learning logic toward SL related subject and adjust the teaching to the dynamic that can be stimulated based on the content and the balance between those, but also to understand how their students' living environment experiences by inducing representations and perceptions of sciences related aspects of their society and world might be an important source of affects and attitudes on these learning objects. However as the individual grows in his living environment he internalize in a personal manner some aspects of his living environment and has a representation of himself in this environment and this become part of his personality. Because reaching adolescence these various representations of the self in the living environment are reaching some stage of maturity and lead to planed and controlled behaviors as well as of the projections in a future living environment it seems important to have some information on these traits of the students' personalities. The responses and traits tested are not independent from the previous aspects of the students' living environment however the items, chosen in this subjective dimension of the living environment in relation to sciences objects, are proposing activities that are not relying or requiring interventions of the adults.

The most striking trends in the two subgroups sustaining the P4 and P8 idealtypes in the French 15 years old population are observed at the levels of the spontaneous curiosity leading to open up the everyday life objects which functioning is hided inside and at the level of spontaneous cognitive activity searching for coherence and associative links between what is learn in sciences in the other disciplines. Obviously the P4 students express much more these trends compared to the P8 students and to the national sample group.

Finally we found also that the students in the two subgroups express with highly different level the personal traits relative to the value of sciences learning and knowledge and the present and future engagements toward sciences in their life. This can be explained by the fact that the P4 students find sciences easy and have obviously many out-of school activities and familial environment that increase there sciences scientific literacy knowledge and competences; they are thus valorized by school taught sciences and put value on taught sciences. In contrast the P8 students express more frequently difficulties in sciences classes, and they have less prior knowledge on sciences and scientific literacy knowledge and competences, as a consequence they are valorizing a knowledge that can not valorized them selves and may have even be negative for their self esteem in the sciences classes environment. The P4 and P8 learning orientations can thus be related simply to a mechanism of protection of the self esteem. However it can also be simply traits due to an imitation of the main stream view on sciences expressed in the P4 familial and socio-cultural environment and conversely to the minorities streams that are not having such high value on sciences expressed in the P8 micro-cultural environments

In conclusion, SIA and secondary analyses of the contribution of supplementary variables informing on students' living environment perception, experiences and representations, permit when applied to the profiles expressing coherent positive or negative learning attitudes on sciences and society matters to give some insight to the teachers on their students' motivation to learn on such matters. The latter are following the reform of 2006 a goal of sciences education that should be aimed at developing functional sciences literacy for all future citizens. Our model of the classroom group propose that on such SL related subjects there are two main subgroups with stable attitudinal profiles that will have opposite affect on these SL learning goals linking sciences , society and planetary challenges. This model permits to the teachers to consider the profiles contents and structures in order to design more adjusted activities and to anticipate the balance between positive and negative orientation in order to manage the learning dynamic. With the added information of the present study, the teacher can by understanding the potential origin of such opposite learning orientations stimulate students' expressions of their mobiles. The exchanges in a safe and free classroom context (Brown, 1998) should permit to reveal the differences in the representations knowledge and experiences with the living environment and should permit, through the exchanges between the students with high level of readiness and at the opposite low level of readiness to learn on the SL required in their everyday life and future citizenship, to share their knowledge and views. This should permit to proceed to cognitive redefinition that might improve the learning orientation toward the development of functional scientific literacy. Indeed it appears that the students' expressing the profile (P8) implying a low readiness to learn on such SL related activities suffer mostly of a lack of representations experience and knowledge allowing them to have willingness to engage learning effort on objects they have not noticed or encountered or talk about in their living environment. Our study using supplementary variables describing some traits related to various dimension of the student living environment shows that those reveal tendencies affecting the two opposite students' subgroups of the French adolescent population. The P4 and P8 difference of learning orientations finds some grounds in the diversity of the students' origins. Indeed our modern societies presents various socio-economic classes, various subpopulation with different level of education and this defined micro-cultural streams aside from the mainstream culture the teachers have and teach. These streams in which the students evolve and interact with what the society offers influence the ability and the interest for subjects related to sciences and the society which are now integrated in the sciences curriculums. These subjects should not be considered as disciplinary and should not be a centre of avoidance for the students with low achievements in sciences. However, in contrast to what is generally thought a problem of motivation linked to the students' diversity may occur on these SL related subjects and teachers should expect that and be prepared to understand this problem.

## References

[1] Brown, R. (1988) *Group Processes*, Eds Blackwell Publishing MA, USA.

[2] Clark, C. (2000) Effective multicultural curriculum transformation in “advanced” mathematic and hard sciences. Available at: http://www.diversityweb.org/digest/fw02/mathscience.html.

[3] Ernst, M. Fudge, J. (2009) A developmental neurobiological model of motivated behaviour: Anatomy, connectivity and ontogeny of the triadic nodes. 33(3)367-382.

[4] Fazio, R.H. (2007) Attitudes as object-evaluation associations of varying strength. *Social Cognition*, vol. 25, n°5, 603-637.

[5] Gras R., Kuntz P., Briand H. (2001). Les fondements de l’analyse statistique implicative. *Mathématiques et Sciences Humaines*, n°154-155.

[6] Gollwitzer, P.M. and Brandstaetter, V. (1995) Motivation. pp 397-403 In A.S.R. Manstead & M. Hewstone (Eds) *Blackwell Encyclopedia of Social Behaviour*, Oxford: Blackwell Publishers.

[7] Lee, O. and Luykx, A. (2006) Sciences education and student diversity. *Cambridge press university press,* NY 10011-4211, USA.

[8] Marks, G. (1999) The measurement of socioeconomic status and social class in the LSAY Project, *Technical report n°14* http://research.acer.educ.au/lsay_technical.

[9] Montpied P., Le Hebel F., Fontanieu V. (2010) La diversité des désirs d’apprendre : quelles informations pratiques l’Analyse Statistique implicative fournit-elle en regard des curriculums et de l’enseignement des sciences, Proceeding of the 5th International Conferences on SIA, Palermo, Italie, p257-272.

[10] OECD (2001) A report of learning sciences and Brain research. Potential implication for educational policies and practices : Brain mechanisms and youth Learning. *Second High Level Forum of Learning science and Brain research, Granada, Spain, February 2001 www.**oecd**.org/data**oecd**/40/40/15302628.pdf*

[11] Oortwijn, M., Boekaerts, M. and Vedder, P. (2008) The impact of the teacher’s role and pupils’ ethnicity and prior knowledge on pupils performance and motivation to cooperate. *Instr. Sci*. 36, 251-268.

[12] Osborne, J. (2007) Science education for the twenty first century. *Eurasia J of Mathematics, Science & Technology Education*, 3 (3), 173-184.

[13] Robert, D.A. (2007). Scientific literacy / science literacy. In *Handbook of Research on Science Education* Sandra K Abell & Norman G. Lederman (Eds), New Jersey. Chap 4, pp729-780.

[14] Rowe, G., Hirsh, J.B. and Anderson, K. (2006) Positive affect increases the breadth of attentional selection. *Proc. Natl. Acad. Sci. USA,* 104(1), 383-388.

[15] Ryder, J. (2001) Identifying science understanding for functional scientific literacy, *Studies in sciences education*, 36, 1-44.

[16] Schreiner, C. & Sjoberg, S. (2004) Sowing the seeds of ROSE: Background, rational, questionnaire development and data collection for ROSE (the Relevance Of Science Education). *Acta didactica*, n°4, University of Oslo. Disponible à: http://folk.uio.no/sveinsj.

[17] Steinberg, L.(2010) Commentary : A behavioral scientist looks at the science of adolescent brain development. *Brain Cognition*, 71 (1), 160-164.

[18] Venturini, P. (2004) Attitudes des élèves envers les sciences : le point des recherches. *Revue française de pédagogie*, n°149, 97-123.

[19] Veder-Weiss, D. and Fortus, D. (2011) Adolescents' declining motivation to learn science : Inevitable or not ?, *J. of Research in Science Teaching*, 48 (2),199-216.

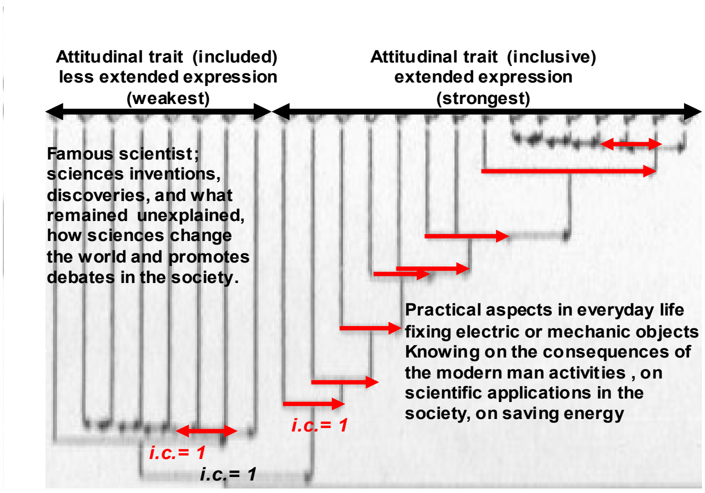
[20] Wit, A.P. and Kerr, N.L. (2002) "Me versus just us all" categorization and cooperation in nested social dilemmas. J. Pers. Soc. Psychol. 83 (3), 616-637.

# Appendix 1 :

*Example of treatment made in a previous SIA work for the profile P4 of learning attitudes representing the hierarchy of choices reasoned by the idealtype students' subgroup declaring interest for subjects proper to develop their scientific literacy:*

The P4 profile is one of the 17 cohesitif trees found through the Statistical Implicative Analysis (SIA) of the 218 types of potential students attitudinal responses (109 subjects inducing either positive or a negative learning attitude) in the 2124 students of our 15 years old national sample.

This tree represents the profile P4 corresponding to the coherent association of 23 attitudes which statistically are similarly expressed in a significant student subgroup of the sample (the forth in size compared to the other profiles).



This association comprise the following choices (noted along with the ROSE questionnaire lettering http://wwww.ils.uio.no/english/rose and with the abbreviation 'int' standing for 'interested' which is the positive attitudinal pole chosen by the students) : [E37int-(E34int E35int) E36int) E38int) E39int) E40int) E42int)] [E28int-E20int-E03int-C03int-A47int-A33int-A30int-A19int-(AO2int A18int) A31int) A32int) A46int) A48int) E41int)]

These choices reveal a focus on subjects more specifically related to scientific literacy topics: history of sciences, the nature of sciences, the relations of sciences and society with the associated issues, and the S&T in our everyday life. The literal translation of the attitudinal implicative relations corresponding to the P4 idealtype profile permit to understand the detail logic and meaning of the students' subgroup learning orientation:

> The students in the subgroup sustaining the P4 idealtype profile, tend to express two principical attitudinal traits and the relation of implication between those indicates that statistically when the students express the first trait corresponding to interest in learning on famous scientist and their lives, on phenomena that scientist still can not explain, on inventions and discoveries that have changed the world, on how scientific ideas challenge sometimes religion, authority and tradition, on big blunders and mistakes in research and inventions, on scientists disagreement, on the reason why religion and sciences are sometimes in conflict, they also express the second trait broadly expressed in the entire group of contributors to idealtype profile P4. This last trait corresponds to the interest in learning on how to use and repair everyday electrical and mechanical equipment, on how energy can be saved or used in a more effective way, on the ozone layer and how humans may affect it, on the use of lasers for technical purposes, on how petrol and diesel engines work, on the effect of strong electric shock and lightning on the human body, on how the atom bomb functions, on the light around us that we cannot see, on recent inventions and discoveries in sciences and technology, on how a nuclear power plant functions , on how X-rays, ultrasounds etc. are used in medicine, on biological and chemical weapons and their effects on human, on explosive chemicals, on how radioactivity affect human body, on chemicals, their properties and how they react

# Appendix 2:

*Example of the report given by CHIC on the contribution to the profiles P4 and P8 of some supplementary variables informing on various dimensions of the students' living environment defined on the basis of their responses to items of the section H:*

The profiles P4 and P8 are defined respectively by the class of contribution at the rank of the hierarchy 198 and 191. The supplementary variables' contributions to these classes which are our central interest are given by a secondary analysis of the primary SIA integrated to the CHIC software. These analyses reports have the following format:

On the first and second lines the responses to the items of the questionnaire linked in the cohesive tree corresponding to the P4 and P8 the profile. For the P4 profile the responses are all on the positive pole a trend noted « trint » for « très intéressé » in

French. For the P8 profile the responses are all on the negative pole a trend noted « padt » for « pas du tout intéressé » in French. Then the cohesitive classes comprised in the tree representing the profile structure are listed. The optimal group is then detailed and the cardinal (GO) give the number of students in the national sample belonging to these subgroups. The secondary analysis of the supplementary variables built on several items of the questionnaire show the contributions and the intersections size with the optimal group. Some examples are shown.

**Contribution à la classe (corresponding to P4 profile):**

E37trint,E34trint,E35trint,E36trint,E38trint,E39trint,E40trint,E42trint,E28trint,E20trint,E03trint,C03trint,A47trint,A33trint,A30trint,A19trint,AO2trint,A18trint,A31trint,A32trint,A46trint,A48trint,E41trint ( 5,6,7,8,9,10,24,60,61,81,84,114,143,157,168,169,170,171,172,173,178,198 )
Groupe optimal :
E1344 E1236 E1828 E1578 E937 E1465 E1595 E117 E298 E1596 E389 E1823 E2003 E1677 E833 E504 E554 E240 E1318 E1698 E762 E1133 E1990 E13 E2069 E2008 E1742 E1458 E120 E1784 E1870 E1829 E58
**card GO 515** p 0.242 1-p 0.758
La variable H03jam contribue à cette classe avec un risque de : 0.999
intersection avec le groupe optimal 62
La variable H03souv contribue à cette classe avec un risque de : 3.99e-008
intersection avec le groupe optimal 143
La variable H05jam contribue à cette classe avec un risque de : 0.774
intersection avec le groupe optimal 59
La variable H05souv contribue à cette classe avec un risque de : 0.00336
intersection avec le groupe optimal 127
La variable H06jam contribue à cette classe avec un risque de : 0.83
intersection avec le groupe optimal 243
La variable H06souv contribue à cette classe avec un risque de : 0.126
intersection avec le groupe optimal 51
La variable H07jam contribue à cette classe avec un risque de : 0.941
intersection avec le groupe optimal 196
La variable H07souv contribue à cette classe avec un risque de : 0.435
intersection avec le groupe optimal 72
La variable H09jam contribue à cette classe avec un risque de : 1
intersection avec le groupe optimal 90
La variable H09souv contribue à cette classe avec un risque de : 2.33e-012
intersection avec le groupe optimal 82

**Contribution à la classe (corresponding to P8** profile)

E02padt,C05padt,A35padt,A44padt,A46padt,E42padt,E37padt,E38padt,E39padt,E36padt,E34padt,E28padt,E22padt,E17padt,E19padt,E20padt,E21padt
64,65,86,112,138,139,140,145,156,167,174,175,176,177,181,191 )
Groupe optimal :
E105 E1305 E1695 E209 E1618 E486 E1616 E232 E2081 E1429 E1370 E1880 E2114 E1056 E2117 E1382 E2059 E1319 E258 E1175 E1953 E138 E1691 E445 E1080 E158 E234 E236 E610 E1515 E654 E1686 E633 E455

**card GO 440** p 0.207 1-p 0.793
La variable H03jam contribue à cette classe avec un risque de : 0.000327
intersection avec le groupe optimal 102
La variable H03souv contribue à cette classe avec un risque de : 1
intersection avec le groupe optimal 50
La variable H05jam contribue à cette classe avec un risque de : 1.4e-012
intersection avec le groupe optimal 101

La variable H05souv contribue à cette classe avec un risque de : 1
intersection avec le groupe optimal 50
La variable H07jam contribue à cette classe avec un risque de : 0.00012
intersection avec le groupe optimal 229
La variable H07souv contribue à cette classe avec un risque de : 0.982
intersection avec le groupe optimal 46
La variable H09jam contribue à cette classe avec un risque de : 4.19e-010
intersection avec le groupe optimal 195
La variable H09souv contribue à cette classe avec un risque de : 1
intersection avec le groupe optimal 11