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Science and Technology in Undergraduate Students' Worldview. A study in a developing society shaped by globalization: the Chilean case.

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The worldviews of the elites in many globalized developing countries are in a changing transition towards modernity. Which is the role of scientific thought in this process? How is the scientific and technological (S & T) conception of elites (higher education students in this case) related to the promotion of sustainable development? Are new elites more open to advanced values of science-technology and innovation or are they still attached to traditional values? How is this process evolving in developing countries of South America, and particularly in Chile, where worldviews are still influenced by a non secularized mentality? This paper seeks to answer these questions offering some sociological empirical data and interpretation in the context of the gaps in S & T experimented in the globalized knowledge society that is emerging in this XXIth Century.

The main approach of this paper comes from a constructivist perspective of S & T, focusing on the perception of “science and technology among undergraduate students in developing countries.” The empiric data is based on a recent national survey applied to a representative random sample of university undergraduate students from twenty five main Chilean universities².

In recent years the Chilean Higher Education System experienced enormous changes. At the moment 37% of the youths between 18 and 24 years are studying in the Higher Education. More than 60% of them come from families whose parents never attended university.

Many of the current diagnoses about the young university students are that they evidence a significant social “apathy”, the same as the rest of the Chilean youth. The indifference for politics and the lack of motivation for social participation, would be signs of a society that has lost its historical horizons, whose utopias have entered in crisis and its young generations caught by consumerism are not projected toward the future. Many approaches to the young generations in underdeveloped countries as well as developed European countries are similar indeed.

Another important common pre-supposition is that even Chilean society has undergone a deep transformation toward a modernized, liberal and globalized style of life the

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mainstream mentality of the elites continues to be very traditional. If it were the case the traditionalism of the dominant elite - attached to religious traditional views – will be manifest within university students as well, with an evident impact on the refusal or at least mince interest of this social group toward scientific and technological progress in the country.

Contrary to these extended common sense thesis - also diffused by the media - we postulate (by way of a working hypothesis) that there exists in the university students a real interest and motivation toward S & T (In all of them, not only in those studying sciences and engineering). Their apparent "indifference" to social participation is not real in the light of their positive vision of the development of S & T. Additionally their attach to religious values does not contradicts their interest to S & T.

The present paper is an output of a research project carried out at national level about the mentality of the Chilean university students and its relation to science, technology and civic responsibilities. Its main objective from a sociological focus is to diagnose and to interpret, in its context, the orientations toward the S & T of the Chilean university students- as representative of a major social elite - in the historical background of a society in transformation. It is an interpretive analysis from the students mentality - reconstructing their discourse – around a strategic question for the competitive development of the Chilean society agenda in its process of growing integration to the globalized world: the necessity to increase efforts in S & T (investment in Research and Development) and in the formation of human capital.

In December 2005 Chilean Higher Education System had a total of 221 establishments, among them: 63 Universities, the rest were Colleges and Technical Institutes. The university system is divided in two subsystems: a) private universities (38) and b) public universities subsidized by the state (25). This last one is more relevant and includes: sixteen universities of state property and nine private universities with public ends (including six Catholic Universities).

The sample of the present study focused on these last twenty five universities that concentrate 55.5% of the university undergraduate students of the country and where the top ten universities are located. The sampling was done with a Cluster Two Stages Random Sampling method, error estimate not bigger than 0.05 and a confidence level of 95%. Fifteen Universities distributed in ten main cities were selected distributed in the North, Center and South of the country's landscape. The total population studied was 256,471 undergraduate students and the final random sample was of 6,219 university students. Male students of the sample were 51.1% and females were 48.9 percent. The youngest student was 16 years old, the eldest 48 years, being the mode 19 years and the mean 21.07 years. The students of the sample are representative of all of the professional and scientific disciplines offered by the Universities and of different socioeconomic strata. The field work took place mostly during the first academic semester of 2005. The questioner was built from a previous qualitative study, taking in account many precedent quantitative studies on youth and values surveys, and combined different multiple choice, differential semantic and scaling types of questions. It included 117 questions and nearly 400 variables.

The study of Chilean University Students' worldview³ has to consider what sociology of knowledge states: among the multiple realities that the subject faces in his life there is a differentiation in terms of "objectivity" and "reality". The reality of every day life presents itself as "reality par excellence" (Berger and Luckmann, 1966). The world of sciences is another reality that presents itself as "hard reality" because it claims thick social legitimation since it appears as a "verified" type of knowledge.

Even though people neither identify nor do they know the principles of scientific rationality (Desautels and Larochelle, 1987) their daily knowledge is highly influenced by scientific discoveries. This type of popular knowledge of sciences is generated starting from the scientific popularization or of the vulgarization of scientific theories coming from the media or from the school.

This process refers us to the re-appropriation of these contents through a semantic re-elaboration process by which those scientific contents are codified in terms of the everyday knowledge of people (Gonzalez, 2001).

In highly specialized socialization processes related to undergraduate students the re-elaboration of scientific knowledge is supposed to be more sophisticated: the distance from "ignorance" and "ingenuity" of common sense might be more evident. We must not forget that we refer to a social and educational elite. Additionally students are supposed to have been major actors in the process of change in both higher education and society (Green, 1997). And in many regions of the planet, under repressive regimes they have had a relevant role in the struggle for democracy.

In the last decades the Latin American society has undergone great transformations under the globalization process. **Globalization** is a wide term and covers many aspects of the social changes in the recent world history. Furthermore we must not deny the relevant debate on what is and what implies this term⁴.

In the present paper we will understand globalization in terms of at least three combined processes of change happened in the world society in the last decades of the XXth Century: a) the increasing importance and impact of the world capitalist market in nearly all countries; b) the rapid diffusion of new technological, informational and communicational (NTIC) changes and c) the transformation of world culture in a dialectical process of a global dominant culture trying to impose its hegemony from above and the resurgence of local cultures and identities resisting from below.

These three globalizing processes have transformed progressively Chilean and Latin American society from the beginning of the 80's.

In fact in the last two decades Chilean economy has been more opened to the international market of goods and finance and has experienced a rapid development

³ World view in its sociological definition can be considered as the ensemble of collective representations that constructs what the individuals consider the "reality", might it be social or natural and their interrelationship. In these terms students and teachers are considered "cultural beings" that do not communicate *the scientific worldview* (Cobern and Loving, 2000) but rather their own forms of enacting what they consider science and technology as part of a broader worldview.

⁴ See Beck 1998, Bell 1973, Castells 1999, Ianni 1996, Robertson 1992, Wallerstein 1991.

within the Latin American context⁵. The Chilean economy has been integrated to globalized markets: nowadays a great percentage of its GDP depends on international markets⁶. In 2006 the Global Competitiveness Report 2006-2007 of the World Economic Forum ranked Chile 27 out of 125 countries in the Global Competitiveness Index. (First in Latin America).

In second hand Chile has been receiving the impact of the New Technological, Informational and Communicational (NTICs) revolutions: The Global Information Technology Report 2005-2006 in its Networked Readiness Index, ranked Chile 29 out of 115 countries (first in Latin America). In the 2002 National Census a total of 87% of the households owned a color TV and 51% disposed of a Mobil Phone at home. Indeed the country has being transformed and modernized, benefiting from the revolution in technology and communication.

In third place Chilean culture has been transformed: not only because the penetration of McDonald's fast food restaurants but because of the overall change in culture and styles produced by this mode of production and consumerism (Ritzer, 1996). Notwithstanding the "American way of life" is changing things but still raising new ways of local life and identities as a reaction.

But the impetus of globalization carries on its own contradictions and consumption is a necessary belief for globalization to function. In terms of income inequality in broad terms Latin America and Sub-Saharan Africa register very high levels of inequality, while South Asia and OECD countries register much lower levels. Within this context Chile after Brazil exhibited in 2005 the highest Gini coefficient in Latin America: 57.1 (UNDP, 2005)⁷.

In the context of these economic and social transformations the Higher Educational System is being modified. Chile is not an exception to the main traits of changes in Tertiary Education System in the World (Green 1997; Rama 2002; Torres and Schugurensky 2004).

This new scenario has vast implications for defining concepts such as citizenship and development, and expectations about S & T and their social function.

OPTIMISTIC VIEW OF THE COUNTRY'S FUTURE SCIENTIFIC DEVELOPMENT.

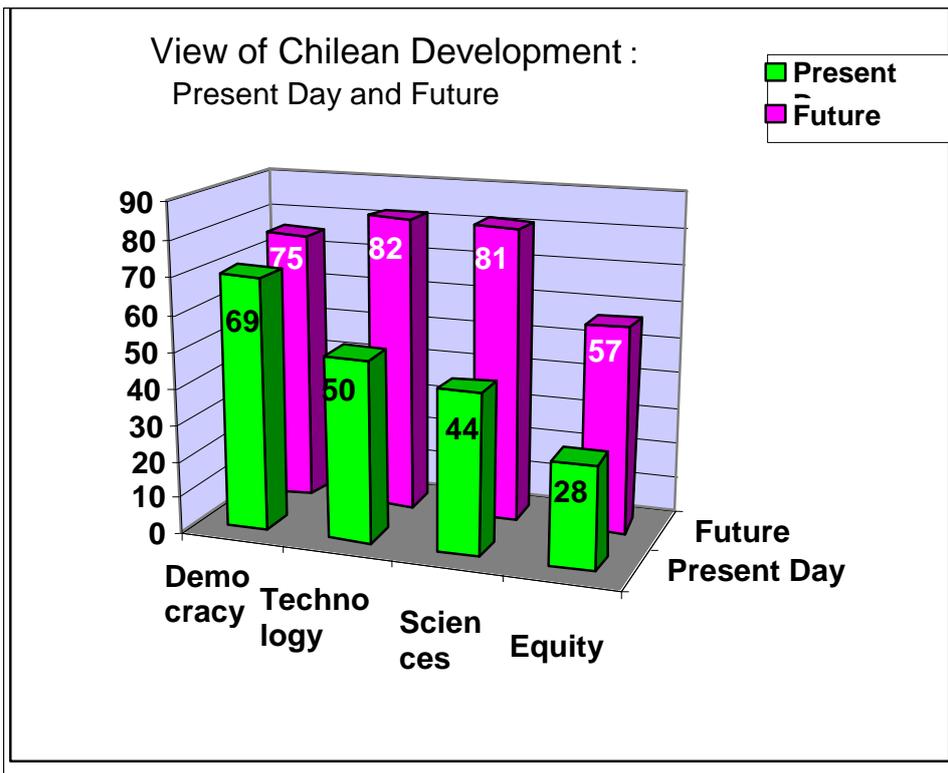
We asked the undergraduate students about their view of the country: present day and future.

Chart N°1: View of Chilean's Future (Percent).

⁵ After a decade of impressive growth rates, Chile experienced a moderate downturn in 1999, brought on by the global economic slowdown. The economy remained sluggish until 2003, when it began to show clear signs of recovery, achieving 3.9% real GDP growth. The Chilean economy finished 2004 with growth of 6.2% and 2005 with growth of 6,3%. Chile was on track to achieve real GDP growth of around 5% in 2006.

⁶ Chile's economy is highly dependent on international trade. In 2005, exports accounted for about 39% of GDP.

⁷ Consider that countries with Gini coefficients above 50 can be said to be in the high inequality category.



The general appreciation of Chilean accomplishment is favorable in economic terms (66% declared they observed a stable economy) but not favorable in terms of social justice (72% of the interviewees declared they observe inequity). The recovery of democracy after many years of Military Regime⁶ is appreciated by a majority (69%).

In general, university students show that they are aware of the fact that Chile is a country in a process of globalization and that the process of modernization has still a road to fulfill. What is remarkable in terms of the subject being studied is that only half of the students see technological (50%) and scientific (44%) development in the country. This is coherent with the available data of international sources that show a low S & T innovation level in the country's development, a fact that is a mayor deficit in terms of international standards of competitiveness (Lopez-Claros et al 2006).

Nevertheless what is even most important: Chilean undergraduate students have a very positive view towards the future: they imagine that the country will be much more technologically and scientifically developed in the years to come (more than 80% of the students think this way).

POSITIVE VIEW OF SCIENCES AND TECHNOLOGY.

In the context of this optimistic view of the future of S & T development in the country, the real significance of a majority that has a positive image of science can be measured. It must be borne in mind that we are studying worldview in a very specific elite – the undergraduate students – in a country where the whole tertiary education enrollment has

⁶ Chile was governed by the Military Regime that overthrew leftist Allende Government on September 11, 1973. During 17 years the military, led by General Augusto Pinochet took over control of the country, with serious human rights violations and the introduction of a free market economy. Transition to democracy began in 1988 and in 1990 the first democratic president was elected with the support of the "Concertación" coalition.

grown but in which higher education still reaches only 37% of the population in the correspondent age strata⁸. In general terms we observe a broadly favorable view toward sciences on the part of university students. This positive view of sciences coincides also with a positive view of technologies.

We have grouped some indicators from “semantic axes”⁹ with which students valued science and current technologies. The cluster analysis allowed us to establish two typologies: one about the global view of sciences¹⁰ and the other one about the global view on technologies¹¹. The statistical distributions of these types are meaningful: 67% of the students manifest a positive view of Science and 66% of them manifest a positive view of Technology. In other terms there are at least two thirds of the undergraduate students that have a favorable view of S & T.

Men tend to see science more favorably than women (Phi = 0.088 p < 0. 01) but there is a low correlation. They also tend to see technology more favorably than women (Phi = 0.116, p < 0.01, significant correlation). There is no clear association of age and socioeconomic strata with visions of S & T. Students holding natural and engineering sciences programs tend to have a more positive view of S & T than students from human and social sciences programs (Cramer’s V = 0.250; p value < 0.01 for Sciences and Cramer’s V = 0.214; p value < 0.01 for Technology).

A 74% of the interviewees consider sciences “very necessary for the development of the country” and 22% “necessary.” But regarding safety in scientific activities the answers inclines the balance toward an intermediate position of ambiguity (71%). In sum science doesn't appear as a contemporary human safe activity, immune of danger.

In synthesis the collective representation of science in the undergraduate mind is guided, for most students, in favor of sciences because they represent progress. The “non scientific world” represents backwardness. Nevertheless science is not regarded as a fully safe activity.

HIGH INTEREST FOR SCIENCES.

In full agreement with what we have analyzed we observe that there is a majority of students that manifest being “interested” in science (or attracted to sciences).

Table N°1: Interest in Science (Valid Percent):

MOTIVATION FOR SCIENCES (semantic axe in percentages)					
I am interested in	58.3	28.0	9.0	4.7	I don't care
Addition of	86.4	-----	-----	13.6	

⁸ Meanwhile in other countries as Spain, it is 56%; in New Zeland 62%, and in Finland 83%.

⁹ Some questions of the survey were constructed by the semantic differential method.

¹⁰ The positive view of sciences was associated with the following sentences: “necessary for the development of the country”; “contribute with valid knowledge”; “positive for humanity's progress”; “I am interested in”.

¹¹ The positive view of technology was associated with the following terms or sentences: “modernity”; “necessary for the development of the country”; “contribute with effective solutions”; “innovative”; “I am interested in”.

A relevant majority of 86% of the interviewees manifest interest for sciences. Men tend to be more interested in sciences than women ($\Phi = 0.138$, $p < 0.01$); Middle age students (21-24) tend to be more concerned with sciences but there's no significant correlation ($Rho = -0.010$, $p_value > 0.05$); those students coming from a better Secondary Education (High or Middle class schools, regardless of their being Private or Public) tend to be more involved in sciences (Cramer's $V = 0.055$, $p_value < 0.05$); and the same tendency is observed of those manifesting a better educational capital (Kendall's $\tau\text{-b} = 0.039$, $p_value < 0.01$); Students from natural sciences programs are the most interested in sciences, followed by students from medical and agricultural sciences, then engineering sciences and those with less interest are students from social sciences and humanities (Cramer's $V = 0.288$; $p_value < 0.01$). Socioeconomic strata has a random influence in interest for sciences: students from quintiles fourth and second are more interested in sciences, those coming from fifth quintile more indifferent. Finally those students performing better in their current studies declare to be more attracted by sciences ($Rho = 0.070$; $p_value < 0.01$).

The use of Mass Media is frequent. A 75% watches television at least once a day and only 9% hardly ever or never. A 50% accesses Internet at least daily, an 83% does it at least once a week and 17% hardly ever or never.

The interest for science is not affected by television or radio. On the other hand the most frequent use of Internet or the reading of magazines are more associated (although in a weak relation) to a bigger interest for science. (Cramer's $V = 0.045$; $p_value < 0.05$ and Cramer's $V = 0.062$; $p_value < 0.01$ respectively).

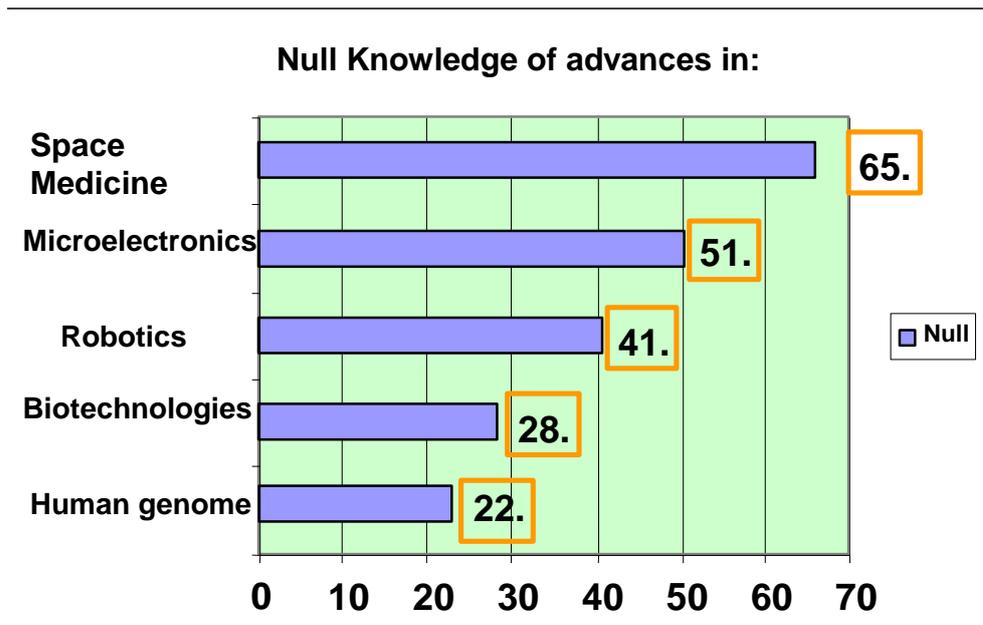
However, as we have observed there is no consent about the consequences of scientific activity and of their products: science contributes with valid knowledge, but its concerns are not always oriented to "real problems" and their consequences are far from being clearly safe. This ambiguity in the appreciation of sciences might be related with ethical judgments about sciences.

Sciences, in the collective representation, being a product of a positive human activity, are not neutral and their products and consequences bear risks that have to be evaluated in each occurrence.

SCIENTIFIC LITERACY AND DEGREE OF KNOWLEDGE OF ADVANCES IN VARIOS FIELDS.

The view of a certain reality is influenced by some factors being available information and socialization two key factors among them. Let us observe the "basic knowledge" declared by the students in this area. The fact is that undergraduate students reveal scarce knowledge of advanced scientific knowledge:

Chart N° 2: Knowledge of scientific advances (Valid Percent).



On biological sciences, such as biotechnologies and human genome students seem to have bigger information (72% and 78% of knowledge, respectively). Maybe this can be accounted for by media publicity on these scientific advances.

Advanced and specialized knowledge linked to highly developed countries as “medical sciences of space”, are the less known for Chilean students (only 34% of knowledge). Highly developed knowledge of recent scientific revolutions such as microelectronics and robotics get an intermediate level of knowledge (51% and 41% of ignorance respectively).

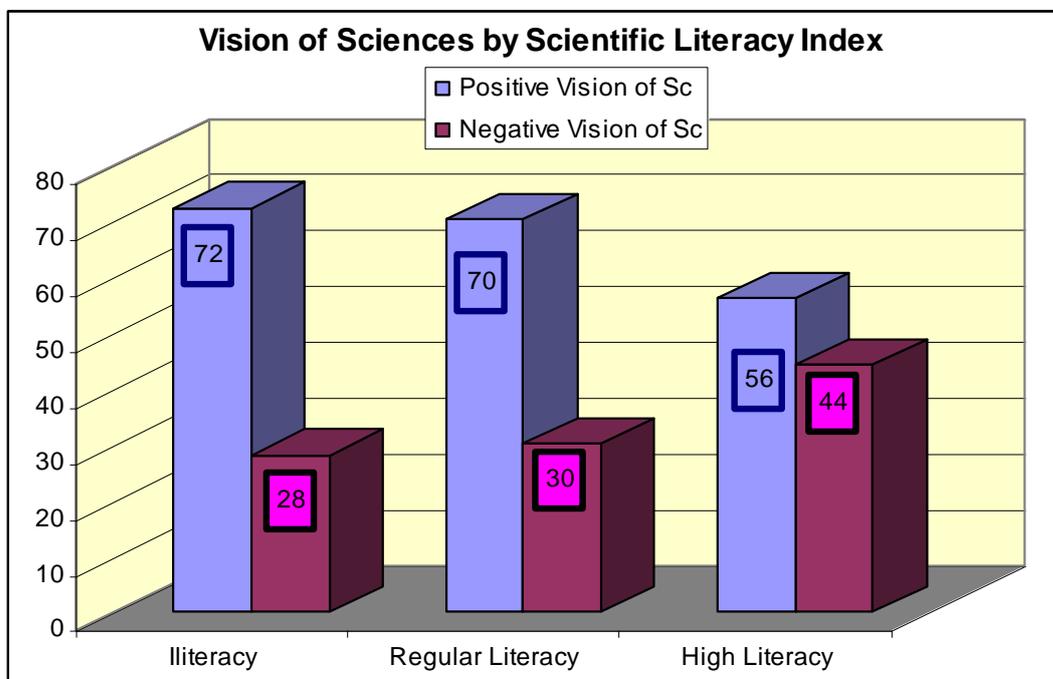
Concerning scientific knowledge we must refer to scientific literacy. In highly developed countries for decades scientific literacy for all (DeBoer, 2000) has been considered a key standard to be reached in educational achievements. As the *National Science Education Standards* states: “in a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone” (National Committee on Science Education Standards and Assessment, National Research Council, 1996).

In Latin America there have been a series of educational initiatives promoted by international organism as UNESCO (COPAE A.L.- UNESCO, 1995; Macedo, Katzkowicz, 2004) on scientific literacy but with a limited impact in the educational systems of the region. Considered as a process of cultural development (personal and social), the assimilation of scientific perspectives is perceived as a positive value in any person's education by providing essential concepts, procedures, and attitudes for a rational and effective approach to things, processes and problems of material reality (Cañal, 2004).

Scientific literacy was not the central objective of the present investigation, notwithstanding our “proxy” indicator included: degrees of basic knowledge of some “advanced knowledge”; degrees of familiarity with great “scientific personalities” of the XXth Century; and manifested “attraction” in watching scientific programs in television.

The results were: 27% manifested indexes of “Scientific Illiteracy”; 44% of medium “Scientific Literacy” and only 29% reasonable “Scientific Literacy”. A cross tabulation of these data by the view of sciences shows a clear tendency. To a higher Scientific Literacy corresponds a more negative vision of sciences. To a lower Scientific Literacy corresponds the tendency to have a positive view of sciences.

Chart N°3: View of Sciences by Scientific Literacy (Percent).



Foreseeing the needs of the society of knowledge and with the foregone advances of sciences and technology in the future, we can conclude that we are facing a clear manifestation of inadequacy in the “Scientific Literacy” index. Indeed we are analyzing a social group composed by tertiary students that are supposed to have the best and renewed knowledge in the country, being as they are supposed to be, the country’s professional elite of the future, the best elements of human advanced capital.

The data we have analyzed are revealing that Scientific Illiteracy (bigger ignorance of sciences) engenders a rather positive view of sciences, a common sense, ‘ingenuity’ view, that understands sciences in an idealized and ideological way – originated in ignorance and in the greater influence of media and its stereotypes.

On the contrary for those students that manifest a better scientific literary index their view of sciences tend to be more critical. This might be interpreted as the fact that a better information and an evident interest for sciences can produce in the mind of students a clearer understanding of the risks and problems sciences might have in the social and private lives of people. As we will observe, in concordance with this interpretation, the majority of students tend to have a more *critical* way of assessing sciences.

SCIENCES AND TRANSFORMATION OF NATURE.

S & T, in the sense which is being discussed here, refer to social activities of men in face of Nature: the first highlighting knowledge, the second putting the accent on

transformational processes. The question here is how is it that S & T perceptions of elites (undergraduate Students in this case) related to Nature and to promotion of sustainable development are constructed?

As it is well known the ecological awareness in the world is growing with the ecological problems of Planet Earth. Many voices stand to state that S & T, no matter how powerful, cannot save the world from ecological disaster.

The accelerated development of S & T apart from great advances for humanity has triggered ecological problems that have impacted everyday life at the beginning of the XXI Century (Gil-Pérez, Vilches, González 2002). The general ecological balance has been violated and man has to face the emergence of unexpected processes in nature, including the failure of its natural reproductive power. The international community is having a public commitment that emphasizes the need for environment programs and sustainable development¹².

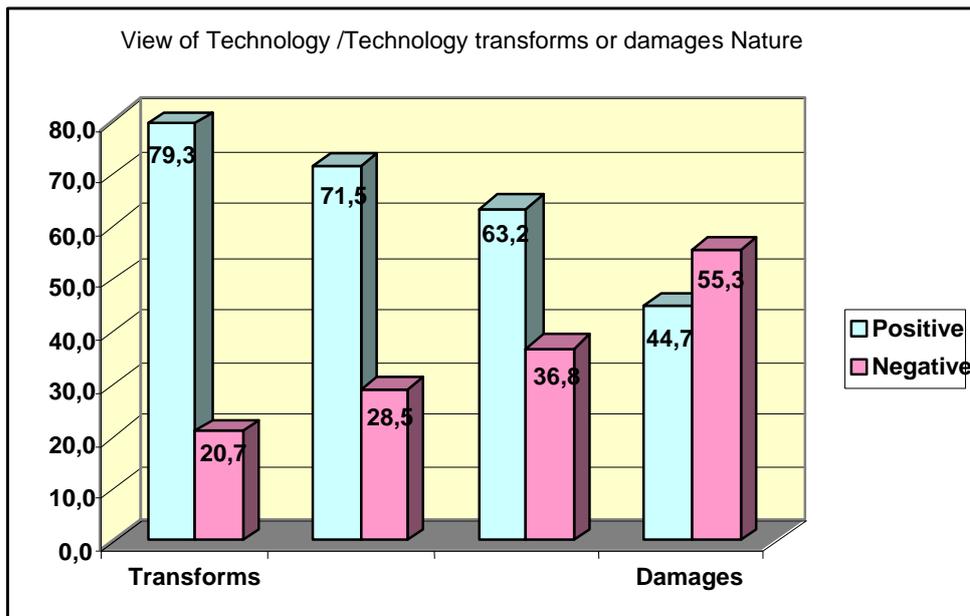
In this context, Chilean students were asked to manifest their options in front of the following dilemmas: “Human beings should dominate nature” or “human beings should coexist with nature”. The first enlightened attitude considers human beings at a particular position outside nature, imposing their decisions and actions upon it. The second holistic vision considers human beings as being part of the living planet as a unified whole biosphere thus living in harmony with nature.

The answers of the students are clear: an overwhelming majority supports the idea that humankind must coexist with and not dominate nature (86%). If we have this massive ecological way of thinking we can expect that technology will be seen as negative for nature. Remember a 66% had a positive view of technology.

In fact the negative view of technology is related to the perception that it is a way of damaging nature. Asked about the damages provoked by technology 45% of the students agrees with this idea. A 55% of the interviewees affirm that technology transforms (and not damages) nature. This perception of technology with regards to nature is the background of the typology of views on technology analyzed before:

Chart N°4: View of Technology by Technology and Nature (Valid Percentages).

¹² Together with the Brundtland Commission (1987) and the Earth Summit (Eco '92) in Rio de Janeiro 1992 (with Agenda 21) and the Johannesburg's Earth Summit 2002, that explicitly treated the subject, we must consider the important place given to environment and sustainable development by the Millennium Development Goals by 2015 and by the 2005 World Summit that proposed 2008 to be the “International Year of Planet Earth, 2008”.



The negative view of technology is strongly influenced by the social perception that technology has negative impacts over nature and biological cycles.

The results show a more sophisticated way of thinking: Students seems to agree that technology might damage nature so you have to take distance from it (negative view of technology) but their view of nature (subject of human dominance or not) is only partially correlated with the view of technology.

Table N°2: Opinion about Technology by Vision of Relationship Men-Nature (Valid Percent).

Man with Nature	Technology:		
	Transforms	Damages	
Dominate	69.4	30.6	100
Coexist	52.0	48.0	100

Those stating that man must dominate nature tend to see technology as a positive transforming action of nature. On the contrary the view that affirms that man must coexist with nature tends to see technology as a danger for nature. The relations are significant (Cramer's V= 0.108; p_value < 0.01).

The question is now to determine what happens with this ecological view of nature and the viewpoint of sciences. On this case, the relevance of an ecological view within the university students' worldview is slightly influenced by the view of sciences.

Table N°3: View of Relationship of Man-Nature by the view of Sciences (Valid Percent).

Dominate or coexist with Nature by View of Sciences

View of Science	<i>Dominate +</i>	<i>Dominate</i>	<i>Coexist</i>	<i>Coexist +</i>	<i>Total</i>
Positive	5.2	9.2	18.2	67.4	100
Negative	3.8	10.5	23.7	61.9	100
Mean	4.8	9.6	20.0	65.6	100

Those having a positive view of sciences tend to support the fact that men have to coexist with nature. Those having a negative view of sciences tend to support a middle position. But the association being significant is not strong (Cramer's $V = 0.075$; $p_value < 0.01$).

On the contrary, the ecological concern together with a potential favorable option for sustainable development is clear in the way the students see the future of the country:

Table N°4: The future of the country (Semantic axes; Valid Percent).

CHILE IN THE FUTURE	(Percentage)		
Without pollution	43	57	Polluted
Thinking of the future	73	27	Thinking of the past
Humanized	45	55	De-humanized
With more sciences	81	19	With less sciences

The main problem in the future of the country will be, according to the majority students' discourse: pollution. The country will be "thinking of the future" and have a highly developed scientific system, but for the majority it will have ecological problems and it will be de-humanized.

This question of a future grounded on sciences but de-humanized has to do with the classical apprehension that modern critical thinking has had with the development of Techno- Sciences¹³.

Science fiction literature has often referred to this anguishing question, for example in Huxley's *Brave New World*. The fear is of a future world dominated by robots and submitted to the arbitrary and totalitarian power of a technocracy.

The questionnaire asked about the critical reception of this collective representation brought to the public by Hollywood's Industry in the famous film *Matrix* that makes allusion to the same theme.

The text said:

"The film *Matrix* introduces a fight of men against the electronic machines in the computer and virtual world of the future. You think that":

- "It is science fiction; - It may be a reality; - It will surely happen".

Table N°5: Opinion about the Film *Matrix* (Valid Percent).

It is science fiction	35
It may be a reality	58

¹³ Remember authors as Husserl, Marcuse or Habermas and their arguments criticizing techno-science.

It will surely happen	7
Total	100

As we observe at least a third of the students (35%) show a very optimistic view of the future without any risk derived from a highly technologized world. A majority takes distance and thinks that the rebellion of machines can be a future reality (59%). A minority (only 7%) fear that technology and machines will bear the viewpoint on the future.

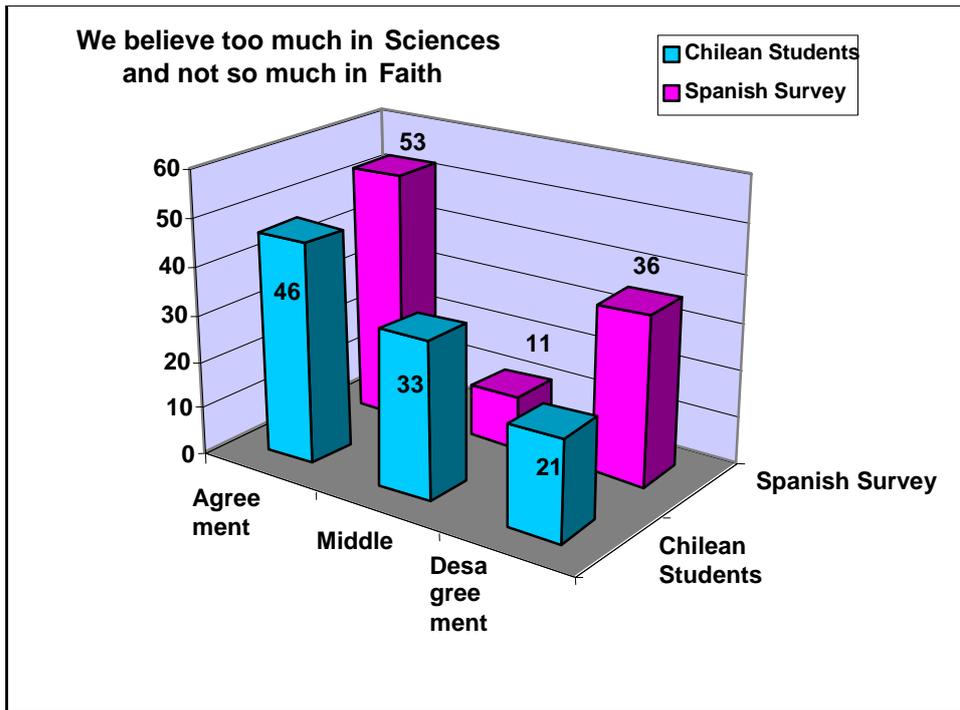
In general terms the view of technology, being positive, takes a critical stance because there is an ethical and humanistic evaluation toward the impacts of technologies in the future. The discourse of a majority of the students is emphasizing that the development of technologies without human control may have a negative impact on nature and even in the evolution of human society.

CRITICAL APPRAISAL OF S&T AND TRADITIONAL RELIGIOUS WORLDVIEW.

On the study of traditional mentality the religious factor happens to be relevant. The main question here is if this critical appraisal of S & T has to do with a traditional religious worldview? In classical terms there is an association of religiosity and traditional values: on the contrary the more “progressive” mentality opened to sciences will be related to absence of Faith. This is the type of relations present in the stereotyped classical positivistic worldview.

The students were asked about the relative value of sciences with respect to religious faith. They had to state their option in front of the following sentence: “we believe too much in Sciences and not so much in Faith”. We compare here the Chilean results with a survey made in Spain for a random sample of the general population, done in 2002. Chilean students agreed with the statement with 46% of the preferences; in a lower degree that those of the Spaniards: 53%. We remember that the main conclusion of the Spanish study is that the Spanish people have undergone a very important process of secularization in the last decades (Perez-Argote and Santiago, 2005). Indeed our Chilean students evidence a relevant degree of secularization of beliefs. But what is significant to point out is that we are not in front of an extreme case of secularization: it is indeed less pronounced that the Spanish case. Only 21% disagrees with the statement, on the contrary around 36% of the Spanish people did so. This last alternative might be interpreted as a “hard” position supporting “sciences” with antireligious denotations. On the contrary Chilean students tend to support a middle position: a third of them with contrast to the Spaniards that opt for a middle position only in an 11%.

Chart N°5: Beliefs and Science: Comparison Chile-Spain (Percentages).



In fact, as we observe the cross table with vision of science we have:

Table N°6: Opinion about science and faith (Valid Percent).

Agreement with the sentence "We believe too much in sciences and not so much in Faith" by View of Sciences:				
View of Sciences	Agreement	Middle	Disagreement	Total
Positive	44.1	31.8	24.1	100
Negative	50.9	34.5	14.6	100

There is a tendency for those that maintain a positive view of sciences to be in disagreement with the sentence, and for the ones with a negative vision of sciences to agree with it. The tendency is not so pronounced but statistically significant (Cramer's $V=0.110$; $p_value < 0.01$). This means that there is a hard pro-science and antireligious position within the undergraduate worldview but it is in any case a minority of them that stand it. Comparing results in terms of the total sample only 16.1 % maintains this hard classical antireligious position. On the contrary 30% of the total sample are in agreement with the sentence (favorable to religion) and have a positive view of sciences.

Results of the crossing table between view of sciences and beliefs in God verify the same tendencies. It can be observed that believing in God is not correlated to the view of sciences. Believers are even a little bit more favorable to sciences (67%) than non believers (64.8%). Some non believers even have a "hard" position against religion (they affirm that God is "a fiction", only "tales") notwithstanding they are not more favorable to science than the rest of their classmates (66.2% vs. 67%).

In addition the general tendency evidences that we are *not* in face of a global *anticlerical positivistic worldview*: 89% of the interviewees disagree with the sentence:

“Religious festivities must be abolished in the name of science and progress”. And the results show that this anticlerical positivistic view of religion is not influenced by the view of sciences. *The generalized favorable view of sciences runs in parallel with a small anticlerical and positivistic view of religion. On the contrary the favorable religious worldview does not mean a necessary negative view of sciences.* As we observe there is a broad scope of positions toward beliefs and religion. The fact is that those “more religious” people tend to maintain their faith without rejecting sciences, and even affirming that sciences are vital for progress and for development.

The general positive view of sciences as we have observed is not linked with a negative view of religion, nor with an ingenuity assessment of scientific or technological impacts in the world. We are not facing a “traditional” (magic or irrational or fundamentalistic) way of thinking: even the most religious people accept science.

Results from other questions reaffirm the presence of a modern mentality that accepts both Faith and Sciences. Indeed a positive view of sciences is related to open-mindedness: the acceptance of new ideas, the exploration of new horizons (71% of all samples). On the contrary traditionalist way of thinking is related to a negative vision of sciences. This view is related to those that affirm that important ideas are those that have endured time and circumstances: they support Tradition vs. Innovation. But this type of thinking is declared by only a 28% of all the interviewees. It is certainly not sufficient to support the classical hypothesis that gives credit to the maintenance of a traditional worldview – refractory to science - in developing countries elites.

THE ETHICAL ASSESSMENT OF S & T.

If it is not a traditional mentality the main factor that underlies the negative view of sciences, what about other arguments? A broader analysis of our results permit us to state that the critical appraisal of S & T that have been mentioned above is surely inspired in an ethical assessment of them. An outstanding 91% of the students affirm that they agree with the sentence: “An ethical and political management of sciences is necessary for the real advance of humanity”.

Crossed by the views of sciences we observe that the students that have the most positive stance are the ones that are very clear about the necessity of an ethical control of sciences (51% full agreement). As we can expect those having a negative position toward sciences will also agree with this statement (but it is important to note that what prevail is “agreement” (59%) and not the “full agreement” (29%).) The association is significant (Cramer’s V= 0.214; p_value < 0.01). Instead, there are a low, but significant percentage of people contrary to sciences that do not agree with the necessity of an ethical assessment of sciences (13% vs. 7% of those in a positive position).

Table N°7: Ethical management of sciences (Valid Percent).

View of Sciences	<i>An ethical and political management of sciences is necessary for the real advance of humanity</i>				Total
	Full agreement	Agreement	Disagree Ment	Full disagreement	
Positive	51.3	41.4	6.0	1.3	100
Negative	29.0	59.1	10.6	1.4	100
Total	44.0	47.2	7.5	1.3	100

This means that for the general and majority position favorable to the development of S & T there is an awareness of the necessity of an ethical and political control of it. On the contrary there is a minority of students that are negative to S & T but neither sees the necessity of an ethical control of it: S & T might be negative but they can develop on their own, with plain autonomy (which reveals a sort of fatalism with this respect).

The humanistic and ethical view of S & T is greater in women. Concerning technology women perceive that it is woven to a de-humanized worldview and its rejection is product of the lack of proximity with this area that is seen (by women and men) as an area of masculine preference. Male undergraduate students, on the other hand, tend to support technology for its positive impact, given its “correct use”, for human's progress and its milieu.

CONCLUSIONS.

Nowadays scientific, technological and advanced knowledge are critical determinants of a country's economic growth and standards of living as well as learning outcomes are eventually transformed into goods and services, greater institutional capacity, a more effective public sector, a stronger civil society, and a better investment climate.

The capacity for countries, and mostly developing countries, to adopt, disseminate, and maximize rapid S & T advances is dependent on adequate systems of tertiary education. Improvements in tertiary education and effective national scientific and innovations systems have to be enlarged in developing countries if the knowledge gaps with the developed countries are to be bridged (Parker, 2005).

In this collective effort S & T disciplines (natural sciences, mathematics and engineering) have an important role to fulfill. Increasingly relevant is the need for education in sciences for all: including nonscientific careers. The formation of a human advanced capital requires that in developing countries students should develop a favorable attitude to S & T.

The evidence found in this research illustrates the fact that Chilean university students have an optimistic view of S & T. Even the critical attitudes toward S & T are not necessarily generated in a traditionalist or fundamentalist thought.

The view that people's social constructs of a certain reality are influenced by many factors: one of them being the amount of information, another the type of socialization process they have undergone, and another the type of “prejudgments” toward this reality encoded in everyday language, and certainly, of course, an important factor deriving from their personal judgments on that reality.

Indeed the students' worldview analyzed is rooted on a Christian background and tradition (they are believers in God (86%) and in Jesus Christ (86%)). But it is clear that the type of mentality underlying these beliefs obeys not to a traditional magic or premodern mentality but to a modern rational cultural code: 70% of the interviewees agree with the sentence “reason is the most important factor for human progress”.

This worldview analyzed here responds to a global rationality that is very coherent. The construction of collective representations does not receive the influence of religious beliefs - in spite of their remaining relevance in a partially secularized mentality - .Much more significant is the inference of media and culture in this globalized society. In the Chilean context, society has undergone a rapid process of globalization, prospective professionals (current students) have a very favorable worldview to modernization, the State reforms and the economic openings, but definitively they are critical of the inequities and of the negative environmental consequences of the capitalist mode of production, trade and current consumption. The hint codes of a more holistic and more ecological worldview appear as a background of a view on S & T: where the concern for a sustainable development, not sufficiently systematized and explicit yet, certainly constitutes an underlying factor to understand the mentality of these new student generations.

The results gathered here certainly support the criticisms made to the theory of secularization. It has been argued that the thesis supporting that religion is irrational and that there is intrinsic incompatibility of science and religion, is a result of the secular “faith” of scholars on the doctrine of secularization (and their antagonism towards “faith”), and not the result of empirical evidence that goes in an opposite direction (see Stark, Iannaccone, Finke, 1996).

On the other hand the conscious of ecological problems have increased in recent times and they are impacting young generations. The announced increase of global warming for 2007 is a visible sign of the times. In this context of a planetary increasing awareness of the ethical implications of S & T, the Chilean students’ statements are not surprising. It is an indicator that their worldview is not particular and that it is somehow interacting with the influences of the international debate on these subjects. Indeed it is precisely in the last decade that international organisms, especially those oriented to education, have recognized the ethical frameworks (Matsuura, 2005) that must inspire the reflections and plans towards sustainable development¹⁴. In fact, the global ecological awareness expressed in the international community has reached for a decade the higher education systems. (Padilla, 2002:35-36).

As we have observed undergraduate students of Chilean universities evidence a better knowledge of S & T and its environmental impacts. This is not new for developed countries: it has been observed in plenty of research conducted in European countries. Actually, Chilean reality in scientific education is not different from others elsewhere. In spite of the advances, the situation it is not at all positive, since many dimensions of scientific education (science and society, science and ethics), considered vital for didactic research, continues to be marginally considered or totally ignored (Solbes and Vilches, 2004).

The teaching of science has been surveyed in students and even in professors in the Spanish case and there has been enough evidence about deficiency in achievements because teaching fails to show a correct vision of science and even many times it has promoted deformed visions of science (Fernández et Al, 2002).

¹⁴ We must remember here that officially in 2003, UNESCO resolved to recognize the Earth Charter as an important ethical framework for sustainable development.

In spite of these failures of the educational system also present in Latin American contexts (Edwards, Gil, Vilches, Praia 2004), Chilean university students are showing a balanced panorama with this respect. The majority of them seem to distinguish their view of science from “Folk” “naive” or “popular” conceptions of science (that in certain sense sacralizes the scientific knowledge as an absolute and unalterable truth).

The fact is relevant: the majority of undergraduate Chilean students promote the development of sciences and they imagine them as a key factor for the domestic development (82% are in agreement with the sentence: “Sciences and Technology must have the first priority, that’s why they must be strongly supported by the State as a key to progress of Chile”). Notwithstanding this clear favorable perspective toward sciences does not preclude undergraduate students from making a critical assessment of them on an ethical perspective. It is relevant to stress that 85% of the interviewees agree with the necessity of ethics, particularly, in the case of biotechnology, robotics and bioinformatics.

What the present research is showing, in a Latin American context, is that there is enough evidence that tertiary students’ worldview might be highly favorable to the development of S & T. Obviously other studies in the field must verify the truth of this statement. Nevertheless it is a fact that the students of our survey, in general terms, are open to new knowledge and innovations, but at the same time they are aware of the dangers and ambiguities that technologies and applied sciences can have in nature and in human society.

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