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Public Perception of Science: Mapping the concepts of Brazilian undergraduate students of the State of Sao Paulo through Structural Equation Modeling

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Abstract: Once modern society depends in large-scale of scientific development, the degree of association between scientific knowledge and attitudes toward science has historical, social and political implications. In this sense, it becomes crucial to analyze the public attitudes regarding to science as these are related to the changing context of scientific practices and their implications for practical problems. Thus, we developed a survey instrument that allowed us to assess the causal relationships and correlations between conceptions, attitudes and socio-demographic factors in relation to science, using as a mediator theme the genetic engineering. Among the socio-demographic factors are included: gender, age, income, religion, schooling, consumption of information provided by the media, perception of knowledge and personal experience. For the composition of the sample, students from various undergraduate courses from public and private institutions were selected. The data were analyzed quantitatively by structural equation modeling. The results show that the conceptions that people have about science directly and positively influence their attitudes towards science. The social factors have their weight, but on a much smaller scale.

Keywords: Science, Public Perception of Science, Attitudes Regarding to Science, Statistical Indicators

1. Introduction

In our work, we aim to obtain a model able to show how society perceives and interacts with science. In this sense, we consider that one of the fundamental concerns currently when trying to relate science, technology and society is the development of indicators to assess the interactions between these three dimensions [1, 2, 3, 4].

The importance of these indicators is recognized, but there are better definitions about its construction and standardization, especially for developing countries. The adaptation of external indicators is fragile and difficult to organize because cultural factors must be taken into account in their preparation. Even though there are adaptations of international indicators, there is a need for validation of these indicators in each of the countries in which it is used [5].

In Brazil, there is a very limited number of researches about public perception of science, contrasting with the importance that this theme has assumed in Europe and United States [6, 7]. This can be directly related to the lack of questioning about the role of citizens in the process of forming the scientific and technological innovations. Brazil doesn't have the tradition of citizen's participation in debates and controversies that involve science.

It is in this context that we present the problem of research that will try to answer: which are the factors that influence the attitudes of people in front of the science in Brazil?

Thus, this paper proposes to show results of a survey whose information could contribute to a theoretical reflection on the development of indicators of public perception of science, assisting in the preparation of measurement instruments adapted to Brazil and bringing elements for the definition of public policies in this area [1].

1.1. Objectives

We chose to develop the instrument about conceptions of science from the perspective of biotechnology (more specifically in the area of genetic engineering) since it is a very controversial topic. Biotechnology is "a new interdisciplinary field that encompasses Botany, zoology, human medicine and pharmacy. The common denominator is the perception that the gene is present in most biological processes" [8]. Biotechnology currently has the character of a horizontal technology that penetrates and diffuses in a wide range of sectors.

In this context, we can state that our goal is to verify, with statistical reliability, if there is any causal link or dependency between the conceptions that people have about science and their attitudes in front of it, mediated by some social indicators.

Thus, this article has as its specific objectives:

i. to present results of bibliographical researches from leading journals in the field (nationals and internationals) and proceedings of symposia and conferences about the major science concepts pointed out by literature;
ii. create probes that reflect a set of attitudes in face of science;
iii. raise the main social indicators that can impact on the attitudes of people regarding to science;
iv. create an instrument of research and propose a model of causality between the conceptions and attitudes, mediated by social indicators;
v. analyze and validate this instrument, through the completion of confirmatory factor analysis.
vi. assess the causality model via of structural equations.

From the results, we will see how people's conceptions about science and the social indicators impact in their attitudes in face of science.

Besides, it is worth mentioning that, despite not being a goal in this investigation, the results of this research can provide indicators for the structuring of public policies related to development and scientific education. In addition, these results can provide subsidies so that we can carry out effective changes in the educational system so that the population can make decisions about scientific issues of social character, helping to make it possible for citizen participation.

1.2. Background

Since the current society depends on large-scale scientific and technological advances, the degree of association between scientific knowledge and attitudes to science has historical, social and political implications that are fundamental. Attitudes to science are crucial in our society, because they can start or stop certain fields [9, 10].

In this sense, it becomes essential to analyze the attitudes of the public front of science, because these are related to the changing context of scientific practices and their implications in practical problems. Our worldview, the self-image of the people, is mediated by our forms of scientific-technological development; a development which is one of the most influential factors about the contemporary society [2].

2. Bases of the Theoretical Model

Two sets of indicators have been used to evaluate the S&T culture: knowledge of science that people have and their attitudes to science and technology. However, these indicators are limited and also been criticized [11, 12].

The concept used in these indicators is based on the design of scientific knowledge as accumulation of knowledge organized and certified as true [2].The biggest problem is that measure scientific culture mainly by knowledge retrieved from encyclopedic definition-based conception of 18th-century culture.

Another important criticism is that often these measures do not take into consideration the scientific and technological know-how, which includes skill and understanding, as opposed to mere knowledge of the facts, nor the ability to deal autonomously with technological artifacts of everyday life. In addition, the focus is exclusively on the individual indicators [13].

The best known are the American, published regularly by the National Science Foundation and the Eurobarometer report, published by the European Union [11,12, 13]. Recently the Organization of Ibero-American States (OEI) and the Ibero-American Network of indicators of Science and Technology (Rycit/Cyted) established some guidelines for the assessment of public perception of science in Ibero-American countries and formulated an instrument. In 2003 this instrument was applied in Brazil, Uruguay, Argentina and Spain in a pre-test form and the results of this research have been published [2]. However, this instrument has not been used regularly to gauge public perception of science in these countries.

Another instrument that has been used to measure the public perception of science is the Oxford Scale. It has three dimensions that include: the contents, methods and the understanding of the impacts of science and technology in society. It's a range of type true/false/I don't know, but according to [14], has some short comings, since the Alpha of Cronbach's of the constructs is low and there is little ability to discriminate among respondents.

Based on the results obtained by the Eurobarometer report, researchers have created the SL model (Scientific Literacy) [9]. This paradigm, also called deficit model, focuses on the thesis of linear dependence between attitude vis-à-vis the science and knowledge, i.e. the person's understanding about the scientific world influences their attitudes to Science [10]. In this approach, the positive attitudes of the public front of science depend on the public's familiarity with the contents and the scientific method.

Analyzing several studies about the SL model (Scientific Literacy), Allum et al. [14], found that although many qualitative and quantitative studies have examined the subject, the results are diverse and even contradictory. Public skepticism in relation to technological innovations such as nuclear energy, microwave and genetic science appear to be markedly reduced if citizens understand more of science on which they are based.

However, this deficitary model of relations between science and the public domain has long been considered problematic from both theoretical and political as empirical point of view [15, 16]. One of its limitations is that it assumes that the differences of understanding among the lay public and scientists are a result of the greater public ignorance [17].

Thus, in order to assess the public perception of science in a more democratic model, you must focus on a variety of perceptions of science in different contexts [14, 18, 19]. From the educational point of view, the students misconceptions about science end up being attributed to deficiencies in quantity and quality, curricular approaches and the current pedagogical practices, unable to transmit and promote appropriate conceptions of Science [20].

In this way, it becomes crucial to be scientifically literate citizens so that they can understand and participate in public discussions of scientific topics and act fully in modern society [15, 21, 22, 23, 24].

However, the question remains: which types of scientific knowledge citizens need to act in society? Or: how to select a limited set of items that people should know? [25].

People should have a deep enough knowledge so that they are able to follow and participate in the discussions of topics related to science [26].

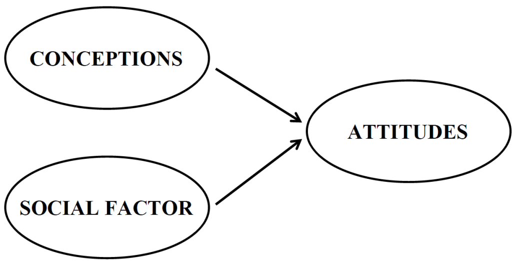

Figure 1. *Theoretical model.*

In this way, new items should be included systematically for an internal consistency of constructs. They should be included in aspects as: knowledge of the activities of scientific institutions, policy of neutrality, the trust in science, science policy effectiveness, risk perception and social values. [6, 10, 14]. The culture, economic factors, political and social values and worldviews influence public attitudes to science [11]. It is in this sense that we propose a model in which both the conceptions about what we call the "social factor" now cause some impact on attitudes to science (Figure 1). In this model, the conceptions and the "social factor" are the historical constructs, also called independent variables exogenous, once its causes are external to the model under analysis. Now the attitude is considered a dependent variable or endogenous.

Based on the theoretical recommendations of the adopted method and starting from these relations, all the variations were tested. So, it was tested two alternative models obtained by exchanging constructs of place, an online linear model in which the social factor influences the conceptions and these, in turn, influence the attitudes of people.

The constructs "conceptions", "attitudes" and "social factor" and its forms of measurement are described in detail below.

3. Methodology

Initially it is necessary to emphasize that our work is divided into two phases:

i. first phase with qualitative approach: bibliographical analysis undertaken according to content analysis techniques aiming to create the instrument probes;
ii. second phase with a quantitative approach: in order to validate the instrument through confirmatory factor analysis and examine it according to multivariate techniques.

In order to show a better organization of the work, we chose to present each of these two methodological steps in two distinct sections.

3.1. First Step: A Qualitative Approach

This first stage of the research is based on a qualitative methodology used to substantiate a first instrument able to investigate the conceptions of science. To do so, were undertaken exploratory research techniques whose aim will be to bring together elements to the composition of the Likert instrument [27, 28]. In this sense, the theoretical framework that will be featuring in this sequence has been explored, sorted, organized and interpreted according to techniques from Content Analysis [27, 28, 29, 30].

In sequence, all material has undergone a process of content analysis and classification of data until they obtained variables. This work has been organized into three distinct poles [30]:

i. pre-analysis: organization of the generated material and a floating reading for the categorization of the obtained data.
ii. exploitation of the material: consisting of the systemic administration of the decisions taken.
iii. treatment of results and interpretation: stage that combines reflection, intuition and the empirical data basis to establish relationships seeking results from raw data, in order to become meaningful and valid.

From this process, the data passed through a coding procedure that corresponds to a transformation of the raw data of the texts (carried out according to precise rules) by choice of units, choice of categories and choice of the counting rules, thus, achieving a representation of the content, or its expression [30].

Starting with the data organized, it was undertaken the categorization of the material that differentiates the data to, in sequence, regroup them in two stages which consist in the isolation of the elements and in the same division in accordance with the rules imposed. The categorization criterion was based on the theoretical references and this kind of strategy was adopted for a simplified representation of the raw data, so they could be catalogued for later analysis.

The results are shown in the following topics, in the creation of the assertions for model previously submitted.

3.1.1. Construct Conceptions

We understand as the conception of science the set of beliefs that a person has about science, whether of science in general, whether of a specific topic. However, this belief does not need to be directly connected to the knowledge on the topic.

The knowledge of the process of scientific research is extremely important for a student to understand the nature of science and the nature of scientific knowledge and thus may have an effective participation in the decision-making about the scientific development [20].

In addition, opinions of individuals from topics related to scientific and technological development imply distinct conceptions of science [31]. For this reason, one of the themes selected to assist in the search for the public perception of science was the area of biotechnology.

To classify and analyze the conceptions about science we rely on the work of Gil Pérez et al [32], but we don't restrict to him. In this way, we summarize six conceptions about science (Table 1), which we will be presented below. These ideas show limited and traditional views about science and scientific research. Despite this, they continue taking part in the social imaginary and has been widely publicized by the media, in the textbooks used by teachers in the classroom, on TV or over the internet.

Table 1. *Assertions regarding the conception of science.*

Conception of science	Understanding of the concept	References
Empirical-inductivity and untheoretical	It is the most found vision in the literature, where science is seen as a neutral activity, devoid of value loads and practical commitments. Namely, observation and experimentation are not influenced by a priori ideas of scientists. In this conception the science is devoid of particular interest both in its conception and development of results.	[2, 32, 33, 34, 35, 36]
Rigid	In this conception, the scientific method is viewed as a set of steps to be followed mechanically, such as an algorithm used to assess the acceptability of general propositions, showing rigorous scientific process control. The science is considered accurate and infallible, algorithmic and its development is governed by a strict code of rationality.	[2, 32, 35]
Non problematic and non historical	Science is taken as a body of knowledge already developed and presented in ready form, without mentioning the problems that gave rise to it, its progress and difficulties. It is a concept widely used in schools, where the teaching practice becomes linked to the frequent use of the textbook and focused on memorization of mechanical concepts, descriptions, rules and mathematical formulas. STS relations are left aside.	[20, 32, 37, 38, 39]
Accumulative with linear growth of scientific knowledge	Science is seen as a progressive and accumulative process of rapprochement of truth, advancing relentlessly and without equivalent alternatives to evolution, complementing the rigid vision.	[2, 32, 33, 40, 41, 42]
Elitist and individualistic of science (self employed)	Science is seen as endowed with its own internal logic. Scientific knowledge are regarded as the work of isolated geniuses, totally uninterested and without goals, being that only the experts have the ability to determine the direction of their advance and no external aspect can influence the development of science. The scientific work is considered reserved dominance to minorities especially gifted and incomprehensible to the lay public. This is an elitist conception fairly treated in the literature.	[2, 32, 33, 43, 44]
Universalist	In this design, the results found by science are valid regardless of cultural, political, social or economical context that generated or who will apply it. It is formulated that the judgment of the relevance, usefulness or results of a work is impersonal and impartial.	[33, 45]

3.1.2. Creation of Probes to Conceptions

All the concepts presented above, in a greater or lesser degree, are part of the social imaginary, and end up preventing an effective public participation in decisions involving science. In addition, there is a significant lack of understanding of the aspects of the scientific processes in the media and in Government reports [46]. Thus, it should be recognized that many audiences have different needs and interpretations about the science and take their decisions on the basis of different criteria [47, 48], which depends on the mediation of a selected issue of science that can be more or less controversial [19, 49].

For the composition of the assertions of the construct "conceptions of science" we use two approaches. The first geared toward a conception of science more generally based on concepts presented previously and the second focusing on biotechnology (more specifically genetic engineering) as the mediator theme, for each of the six concepts presented previously, it was elaborated an assertion referring to that idea (Table 2), which tries to synthesize it.

Table 2. *Assertions regarding the conception of science.*

Conception of science	Assertion	References
Empirical-inductivity and untheoretical	Scientists discover new theories by observing reality.	[2, 32, 33, 34, 35, 36]
rigid	Scientists are extremely strict in the use of the scientific method.	[2, 32, 35]
Non problematic and non historical	Science learned in school has nothing to do with the day-to-day.	[20, 32, 37, 38, 39]

Conception of science	Assertion	References
Accumulative with linear growth of scientific knowledge	The new scientific theories complement the old theories.	[2, 32, 33, 40, 41, 42]
Elitist and individualistic of science (autonomous)	Only scientists are competent to decide what should be researched.	[2, 32, 33, 43, 44]
universalist	The results of the genetic research can be applied to any human being.	[33, 45]

3.1.3. Construct Attitudes

In many parts of the world, the intersection between biotechnology and the public interest has been an important topic to understand the relationship between science and public. Issues such as genetically modified food, manufacturing and pharmaceutical license, cloning, questions about health risks, social consequences and moral acceptability, among others, affect and are affected by individuals and companies. Besides economy, religion and science are the main issues that have implications on public debate about biotechnology [50].

In this area, the controversies have left the restricted area of discussion of experts and become a major issue in the public arena, radically changing how people perceive the living organisms and opening powerful precedent for genetic manipulation [8].

Thus, biotechnology can be seen through six images [50]:

i. Promise: in this category we have 2 ideas: the first would be an image of promise linked to the progress of science (revolutionary impact on science, revolution in medicine) and the second a promise linked to an economic factor (applications in agriculture and pharmaceutical industry involving great fortunes, the human genome as a big deal).
ii. Negative image: could be a fear not specific to a particular technology (pandora's box) or fear linked to a specific theme (fear that parents manipulate their children's genetics, cloning).
iii. Religion: the image of biotechnology also involves religious aspects, especially with regard to cloning, abortion and, why not, miracles.
iv. Natural order: the natural definition contains an implicit hierarchy of values and a set of limits for genetic manipulation, especially human (monsters that do not belong to natural order, chimera). The idea of "natural" depends on the individual but, generally speaking, it is considered that natural is good and unnatural is bad (dangerous). To make decisions about biotechnology are used multiple natural conceptions. [51].
v. Personal genes: human body parts are personified, for example, gay genes.
vi. Image of scientists: once the public refers to scientists for information and understand the various aspects and applications of biotechnology, the image that the public has about them becomes important for decision-making [50].

In this way, people's opinions about biotechnology may reflect general attitudes about the role of science and the scientific risk [52].

Therefore, in addition to the six assertions presented in Table 1, we developed three more related to beliefs in genetic engineering and six relating to knowledge in the area. The probes with the relevant references are presented in Table 3.

Table 3. *Assertions related to biotechnology and genetic engineering.*

Attitudes in face of science	Assertion	References
Genetic engineering	Homosexuality is a genetic trait.	[53]
	The crime trend has a genetic origin.	
	The benefits of genetic engineering are greater than its negative effects.	
Knowledge in the area of biotechnology	In the early months of pregnancy it is already possible to know if your child has a genetic disease or not.	[31]
	More than half of human genes are identical to those of chimpanzees.	
	The cloning of living creatures produces identical beings.	
	It is impossible to insert animal genes in plants.	
	It is possible to transplant a piece of liver.	
	It is possible to create an organ from stem cells.	

3.1.4. Social Factor Construct

For the composition of the assertions of the "social factor", we use again the theme of genetic engineering as a mediator and selective factor in eight issues: sex, income, religion, education, information conveyed by the media consumption, perception of knowledge, age and personal experiences. The choice of each of these categories was made from content analysis, as explained earlier, and the rationale for each category is Table 4.

Table 4. *Assertions related to social factor*

Category	Empirical evidence for choice	References
Gender (Sex)	One of the factors that can influence attitudes to science is the question of genre. Studies show that male students have more positive attitudes to science than the females, specially during the primary and secondary education. An explanation is based on the fact that normally the boys are stimulated in activities that involve the rationality, independence and objectivity, while girls are stimulated in the verbal activities and interpersonal relationships, focusing on emotion and subjectivity. On the other hand, the interaction with models of women scientists stimulates positive attitudes towards science and scientific careers in women. However, the genre should not be used as a direct factor for attitudes. When variables such as education level and religiosity are placed in the model, the effects of variable genre seem to disappear.	[9, 12, 54, 55, 57]
Religion	Religious beliefs may conflict with social aspects to put different views about the nature, identity, separation between species or about the beginning of human life, that can impact heavily on people's attitudes about science. Thus, it is expected that watching religious programs is referenced in a negative way with favorable attitudes to science.	[9, 57, 58]
Age Socio-economical level (income) Education	Personal experience about genetic engineering can affect the attitudes of people. Age and socioeconomic status are variables that must be taken into consideration. People with different socioeconomic levels, ages and schooling have different personal experiences.	[15, 25, 59, 60, 61, 62]
Consumption of information conveyed by the media Perception of knowledge	Currently people watch TV, listen to the radio, visit museums, access the internet, read popular magazines and chat with friends and colleagues to get information about science. These medias are great sources of information about scientific research to the public and the members of the scientific community outside their area of expertise. This type of media differs from the textbooks adopted in schools, would feature the "frontier science", controversial and which is still settling, making a bridge between the scientific community and the public at large, especially with regard to recent scientific discoveries. It is, however, questioned the effectiveness of these means in providing a solid foundation of knowledge whereas who decides which news will broadcast are journalists themselves. Another aspect of this factor that can have an effect on attitudes is the perception of the person in how much someone knows or cares about science. In other words, the perception of uncertainty, which is strongly associated with negative emotions such as concern and anger can influence in probabilistic judgment about some event or expected result.	[15, 25, 52, 58, 59, 60, 61, 62, 63, 64; 65, 66, 67, 68, 69, 70, 71, 72, 73, 74].
Personal experiences	Considering the mediator theme as genetic engineering, personal issues are important factors in the regulation of conceptions and attitudes of individuals against science.	

Based on the theoretical survey and with the justifications presented previously, the chosen assertions were:

a) Gender (male, female)
b) Age
c) Course
d) Year of admission in the course
e) Religion (Catholic, Protestant, Evangelical, atheist, spiritualist, other)
f) Do you consider yourself a religious person? (yes, no)
g) How often do you participate in religious activities? (often, occasionally, once in a while, don't participate)
h) Some member of your family has a genetic disease? (yes, no)
i) Do you have a friend or relative who has had (or have) to do a transplant? (yes, no)
j) How often do you talk to your friends about science? (often, occasionally, once in a while, I don't usually comment)
k) The frequency (every day, a few times a week, a few times a month, every once in a while, no costume) you watched, read or listened to programs which address scientific themes in the last three months in the following media (TV, radio, print magazine, newspaper print, internet)
l) Rate of 0 to 10 your degree of knowledge about genetic engineering.

For the creation of the research instrument, other works contributed in formatting the ideas. Among which, highlights the work of Aikenhead for the elaboration of instruments of perception of science [75, 76, 77, 78], and others related to the sociology of science and technology [79, 80, 81, 82, 83, 84, 85].

3.1.5. Research Tool

The research instrument is composed by 15 assertions regarding to the “conception of science”.

The scale used was built by Rensis Likert in 1932 and is composed of a set of assertions in which respondents are asked to point to one of 5 response options: strongly disagree, disagree, agree or disagree, I agree and I agree completely. In order to treat them quantitatively, it’s given a score ranging from 1 to 5, where 1 = strongly disagree, 2 = disagree, 3 = do not agree nor disagree/don't know, 4 = agree and 5 = I agree completely.

It is noteworthy that the Likert scale is considered an ordinal scale, because the origin of the numbers in that measure is arbitrary and the distance between the numbers are not equal [86].

This scale presents many advantages to the researcher, being easier and faster to be built, with each item going through an empirical test to verify their capabilities of discrimination, as well as providing a greater number of data compared to other scales [87].

Accordingly, we chose the structured questionnaire because it takes less time to be answered; it is easier to answer; it has anonymity and avoids guesses from the interviewer [88].

The validation of the instrument must be done in two ways: theoretical validation and semantic validation [86].

For the theoretical validation of both Likert scale assertions and the questions, we asked seven experts (an educator, two physicists, two engineers, a psychologist and an advertiser) to analyze them in order to verify the appropriateness of these to the proposed theme [89].

For the semantic validation of assertions and questions, we invited 17 college students to answer the questionnaire. Then, an interview was conducted with each of them in order to verify that they understood each assertion and seek suggestions for improving the instrument. In addition, there was also the time required to complete the questionnaire.

3.2. Second Stage: Quantitative Approach

Our research is characterized by a quantitative survey. The advantage of this method is to raise a large amount of information with a certain statistical reliability. Our data were obtained through a sample survey, with closed questions and a Likert scale, and the data were analyzed using multivariate statistical methods.

More specifically, we will perform a statistical approach called "Structural Equation Modeling" (SEM), because it allows the researcher to test hypotheses of relationships among variables. Much of the attractiveness of this technique is due to its generality and flexibility [90]. Furthermore, the application of structural equation modeling is suggested to evaluate the relationship between design, attitudes and social influences, as this analysis will assess the error measures and test direct and indirect relationships between the endogenous variables more accurately, carefully exploring the direction of causal relationships [58, 91].

The concepts of conception, attitudes and social influences that are dormant cannot be measured directly, but only through some indicators. The Structural Equation Modeling allows the researcher to model these latent constructs taking into account that the measurements of indicators contains errors.

So we can use the Structural Equation Model, we must also divide our work in two stages. The first refers to the creation of the measurement model, i.e., determining which variables measure which constructs, since these cannot be observed directly. By construct, we understand:

"An abstraction that the researcher can define in conceptual terms, but which cannot be measured directly (e.g., via a single response that represents the concept altogether), or be measured without error (...) it is the ‘most pure’ possible representation of a concept" [92].

Then we create the structural model, which allows us to establish causal relationships between these same constructs. This model is supported by a solid theoretical basis presented in the previous sections.

Thus, with the Structural Equation Modeling, it is possible to test the fit of the data to a given model. We must, however, highlight the fact that even if the setting is well accepted, other models may provide equally good or superior adjustment, reason for it being convenient to consider alternative models ("rivals") in studies of course also supported by solid theoretical basis in the field of knowledge of the phenomenon focused [93].

4. Methodology

Initially it is worth mentioning that our work is divided into two phases:

4.1. Characteristics of the Sample

Since this work is focused on the education sector, our sample consisted of college students from various courses in the exact sciences and natural sciences, regardless of the year of admission.

The survey technique used was the cross-sectional, widely used which has as basic feature the collection of information of all variables simultaneously [94]. It is noteworthy that the sample was not probabilistic, since the probability of an individual belonging to the sample is not known [94, 95].

Regarding the sample size, although there is no general agreement for the sample size, the amount of 200 has been suggested in some studies [90]. The authors, even pointing out that there is not a sample size considered correct, recommend the adoption of a number between 100 and 200 observations. However, the authors also point out that, in the case of a model WITHOUT the sample size, this should be, more typically, a value that meets the minimum ratio of at least five respondents for each estimated parameter, considering more appropriate a proportion of ten respondents per parameter [81].

Our sample consisted of 1658 students in undergraduate courses of Campinas, Mogi-Mirim, Mogi Guacu, Indaiatuba, Itu, Santa Bárbara d'Oeste, São Paulo and São Carlos, where 20,4% came from public colleges and 79,6% belong to private colleges.

Besides, 43,3% (718) were male, 56,6% (939) were female and one person did not answered this question. The average age was 25 years with a standard deviation of 6.4 years. The minimum age of the subjects was 17 years and maximum 56 years.

The subjects studied are spread over 44 undergraduate degrees, as shown in Table 4.

Table 4. *Undergraduate courses*

Course	Frequency	Percentage
Pedagogy	314	18,9
Administration	287	17,3
Nursing	119	7,2
Production Engineering	106	6,4
Computer Science	93	5,6
Technologist in Logistics	79	4,8
Administration - Foreign Trade	79	4,8
Mechanical Engineering	54	3,3
Technologist in Human Resource	44	2,7

Course	Frequency	Percentage
Management		
Business management	41	2,5
Environmental Engineering	41	2,5
Environmental Management	36	2,2
Accounting	35	2,1
Information Systems	34	2,1
Chemical Engineering	32	1,9
Control Engineering and Automation	31	1,9
Not answered	31	1,9
Nutrition	30	1,8
Technology in Analysis and Systems Development	29	1,7
Physical Education	27	1,6
Psychology	25	1,5
Electrical Engineering	16	1
Leisure and Tourism	11	0,7
Obstetrics	10	0,6
Others	54	3,2

The courses with more representation in our sample were teaching (18.9%), administration (17.3%), nursing (7.2%) and production engineering (6.4%). The courses that have a low statistical significance were classified as others, which are Biological Sciences, Engineering (unspecified), Gerontology, Physics, Dance, Literature, Geography, Mathematics, Industrial Engineering, Marketing, Information Technology (IT), Mechatronics Engineering, Visual Arts, Food Engineering, Philosophy, Degree in Chemistry, BS in Chemistry, History, Social Sciences, Public Policy Management and Bachelor in Science.

Figure 2 shows the distribution of subjects according to the year of admission to the undergraduate program.

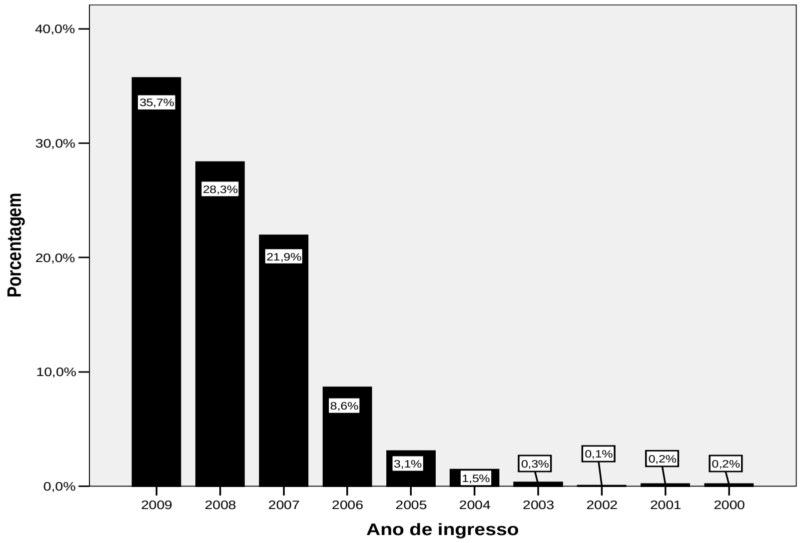

Figure 2. *Year of admission in the undergraduation course.*

The distribution of subjects according to their household income is shown in Table 5.

Table 5. *Household Income*

Income	Frequency	Percentage
Up to R$ 1.500,00	356	21,5
From R$ 1.500,01 to R$ 3.000,00	654	39,4
From R$ 3.000,01 to R$ 5.000,00	360	21,7
Above R$ 5.000,01	265	16,0
Not answered	23	1,4

By Table 5 we find that 60.9% of respondents have a family income up to R$ 3,000.00.

The distribution of subjects according to their religion is presented in Table 6.

Table 6 shows that the subjects are distributed in 26 religions, most of which are Catholic (58.9%), followed by Evangelical (19.9%). On the other hand, 73.4% (in 1217) people consider themselves religious, while 25.3% (419) said they are not.

The frequency of the subjects participating in religious activities is presented in Table 7.

Table 6. *Religion*

Religion	Frequency	Percentage
Catholic	976	58,9
Protestant	45	2,7
Evangelical	330	19,9
Spiritualist	118	7,1
Atheist	50	3,0
Another - without specifying	48	2,9
Other	44	2,7
None	12	0,7
Not answered	35	2,1

Table 7. *Frequency participating in religious activities*

Religion	Frequency	Percentage
Often	603	36,4
Occasionally	259	15,6
Some times	573	34,6
I do not participate	222	13,4
Not answered	1	0,1

Through Table 7 we find that 36.4% of the subjects claim to participate to religious activities frequently. Only 13.4% said they did not participate in activities of this kind.

Regarding personal experiences, only 24.4% (405) of respondents said they had a family member with a genetic disease and only 28.6% (475) said they had a friend or relative who has had (or have) needed to do a transplant.

Table 8 shows the frequency of consumption of information about science in the last three months, separated by media of communication.

Table 8. *Frequency of consumption of information about science in the last 3 months*

Media of communication/ Frequency	Every day	Sometimes a week	Sometimes a month	Occasionally	I have not read, seen	Not answered
TV	246 (14,8%)	580 (35,0%)	285 (17,2%)	456 (27,5%)	74 (4,5%)	17 (1,0%)
Radio	111 (6,7%)	164 (9,9%)	141 (8,5%)	492 (29,7%)	702 (42,3%)	48 (2,9%)
Printed magazine	49 (3,0%)	382 (23,0%)	413 (24,9%)	524 (31,6%)	261 (15,7%)	29 (1,7%)
Newspaper	88 (5,3%)	303 (18,3%)	268 (16,2%)	558 (33,7%)	411 (24,8%)	30 (1,8%)
Internet	470 (28,3%)	508 (30,6%)	257 (15,5%)	324 (19,5%)	86 (5,2%)	13 (0,8%)

Through Table 5 we find that 28.3% of people watched programs or read about science in the whole internet in the last three months and 30.6% did it so a few times a week. Adding these two groups, we have 58.9% of people who watched programs on the Internet at least several times a week. The TV was in second place with 49.8% (14.8 + 35.0).

Regarding magazines and newspapers, people use to read about science in this media a few times a month or once in a while. This can be explained by the fact that some magazines are published monthly and printed newspapers do not always address questions related to science in all its editions. The radio seems to have little importance in the dissemination of science, with 42.3% of people said they heard no programs through this media in the last three months. One hypothesis for this might be the Brazilians do not usually hear on the radio (or hear only music).

With regard to conversations with friends about science, 12.4% (205) reported that often, 25.9% (429) stated that they talk occasionally, 35.8% (594) said that from time to time and 25 7% (426) said they do not usually comment about science with friends. Only 4 (0.2%) subjects failed to answer this question.

4.2. Frequency Analysis

Table 9. *Frequency of consumption of information about science in the last 3 months*

Assertions	Assertion answers					
	1	2	3	4	5	Not answered
The benefits of genetic engineering are greater than their negative effects.	65 (3,9%)	200 (12,1%)	781 (47,1%)	513 (30,9%)	88 (5,3%)	11 (0,7%)
Homosexuality is a genetic trait.	547 (33,0%)	393 (23,7%)	387 (23,3%)	237 (14,3%)	60 (3,6%)	34 (2,1%)
In the early months of pregnancy it is possible to know whether or not the child has a genetic disorder.	50 (3,0%)	134 (8,1%)	414 (25,0%)	779 (47,0%)	276 (16,6%)	5 (0,3%)
The results of genetic research can be applied to any human being.	167 (10,1%)	389 (23,5%)	627 (37,8%)	321 (19,4%)	142 (8,6%)	12 (0,7%)
It is possible to transplant only a piece of liver.	96 (5,8%)	124 (7,5%)	765 (46,1%)	352 (21,2%)	276 (16,6%)	45 (2,7%)
Scientists are extremely strict in the use of the scientific method.	66 (4,0%)	236 (14,2%)	679 (41,0%)	527 (31,8%)	146 (8,8%)	4 (0,2%)
It is possible to create an organ from stem cells.	34 (2,1%)	88 (5,3%)	674 (40,7%)	613 (37,0%)	217 (13,1%)	32 (1,9%)
More than half of human genes are identical to those of chimpanzees.	158 (9,5%)	185 (11,2%)	840 (50,7%)	358 (21,6%)	98 (5,9%)	19 (1,1%)
The cloning of living things produces identical beings.	274 (16,5%)	360 (21,7%)	488 (29,4%)	405 (24,4%)	111 (6,7%)	20 (1,2%)
The new scientific theories complement the old theories.	89 (5,4%)	239 (14,4%)	663 (40,0%)	548 (33,1%)	105 (6,3%)	14 (0,8%)
Scientists discover new theories observing reality.	42 (2,5%)	122 (7,4%)	389 (23,5%)	896 (54,0%)	167 (10,1%)	42 (2,5%)
The tendency to crime has a genetic origin.	665 (40,1%)	457 (27,6%)	355 (21,4%)	119 (7,2%)	45 (2,7%)	17 (1,0%)
The science learned in school has to do with our everyday.	123 (7,4%)	340 (20,5%)	283 (17,1%)	757 (45,7%)	135 (8,1%)	20 (1,2%)
Only scientists have authority to decide what should be researched.	415 (25,0%)	666 (40,2%)	321 (19,4%)	200 (12,1%)	52 (3,1%)	4 (0,2%)
It's impossible to insert animal genes in plants.	166 (10,0%)	234 (14,1%)	1063 (64,1%)	136 (8,2%)	56 (3,4%)	3 (0,2%)

Table 9 shows the responses of the subjects in relation to the assertions of the research instrument.

By Table 6 we found that 81.2% of the subjects said that they would use genetic tests to detect diseases such as cancer or neurological diseases before they appear, while 63.6% said that it is already in the first months of pregnancy that tests can tell if a child has or not a genetic disease. Furthermore, 67.8% agree with the introduction of human genes in bacteria to produce a drug or a vaccine, 59.5% donate their blood (or genetic material) for scientific research and 53.6% claim it should be allowed to create embryos to develop stem cells. On the other hand, 47.4% agree to use genetic manipulation of embryos at the request of parents so that their children do not develop genetic disorders, while 17.3% agree to use it to choose the physical characteristics.

We also found that 84.3% of subjects surveyed do not consider it right to allow companies to use genetic evaluation in the selection of its employees. In addition, 51.5% did not agree to develop genetically modified animals for purposes of scientific research in the medical field and 48.1% disagreed with the introduction of human genes into animals to produce organs for human transplantation. They also consider that neither homosexuality (56.7%) nor the tendency to commit crimes (67.7%) are genetic characteristics.

We also observed that 64.1% agree that scientists discover new theories observing reality, 53.8% say that science learned in school is related to the everyday life, while 65.2% disagree that only scientists have jurisdiction to decide what should be researched.

In relation to the six questions regarding knowledge, we found that in 5 of them, most of the answers were placed in the category of “don’t know”. They are: is it impossible to insert animal genes in plants (64.1%), more than half of human genes are identical to those of chimpanzees (50.7%), is it possible to transplant just a piece of the liver (46.1%), you can create an organ from stem cells (40.7%) and the cloning of living things produces identical beings (38.2%).

In addition, 47.1% could not assess whether the benefits of genetic engineering outweigh its negative effects, 41% say they do not know if scientists are extremely strict in the use of the scientific method, 40% if new scientific theories complement old theories and 37.8% were unable to opine whether the results of genetic research can be applied to any human being.

When asked about their level of knowledge about genetic engineering the mean note was 4.6 with a standard deviation of 1.99. The minimum score was 0 and the maximum 10.

4.3. Confirmatory Factor Analysis

Confirmatory factor analysis aims to verify which set of assertions actually measure the construct analyzed. For this analysis we selected only those subjects who had responded to all questions. Thus, the analysis now has 970 respondents.

All parameters were estimated by the Unweighted Least Squares Method (ULS).

Table 10 shows the remaining variables in the model for each of the constructs and the values of their significance.

Table 10. *Measurement model*

Construct	Variable (assertions ou indicators)	Factor charge	t	(p-value)
Conception of Science	The benefits of genetic engineering are greater than their negative effects.	0,545	26,348	0,0207
	It is possible to create an organ from stem cells.	0,434	21,753	0,0200
	The results of genetic research can be applied to any human being.	0,425	21,345	0,0199
	It is possible to transplant only a piece of a liver.	0,375	19,131	0,0196
	More than half of human genes are identical to those of chimpanzees.	0,335	16,942	0,0198
	In the early months of pregnancy it is possible to know whether or not if the child has a genetic disorder.	0,333	17,197	0,0194
	Scientists discover new theories observing reality.	0,328	16,036	0,0204
	The cloning of living things produces identical beings.	0,282	14,269	0,0197
	The science learned in school has to do with everyday life.	0,258	13,008	0,0199
	The new scientific theories complement the old theories.	0,247	12,282	0,0201
	Scientists are extremely strict in the use of the scientific method.	0,226	11,473	0,0197
	Homosexuality is a genetic trait.	0,192	10,153	0,0189
Attitude	To introduce human genes into a bacterium to produce vaccines or drugs (e.g. insulin for diabetics).	0,551	26,827	0,0205
	I would donate my blood (or genetic material) for scientific research.	0,509	24,915	0,0204
	Would use genetic tests to detect diseases such as cancer or neurological diseases before they appear.	0,505	23,885	0,0211
	The creation of embryos to develop stem cells should be allowed.	0,466	20,750	0,0225
	To use genetic manipulation of embryos at the request of the parents so that their children do not develop genetic disorders.	0,449	20,676	0,0217
	Developing genetically modified animals for purposes of scientific research in the medical field.	0,448	19,959	0,0225
	Introducing human genes into animals to produce human organs for transplantation.	0,444	19,423	0,0229

The values of significance of the test t presented in Table 1 are below 0.05 for all the indicators evaluated, indicating good convergent validity, i.e., the indicators are capable of measuring each of the constructs.

The assertions "allow companies to use genetic evaluation in the selection of its employees" and "using genetic manipulation of embryos at the request of parents for their children to have certain physical characteristics such as eye color" were excluded from the attitude construct.

This can be explained by the fact that 84.3% of the subjects surveyed disagree that one should allow the companies to use genetic evaluation in the selection of their staff. When we perform comparisons by groups (gender, age, course, year of entry, religion,...), we didn't find any significant differences between the groups with regard to this question. In this way, we can say that the sample presented in this assertion is homogeneous.

In relation to "use genetic manipulation of embryos at the request of parents for their children to have certain physical characteristics such as eye color" we found that 67% of the subjects tend to disagree, and that those who participate in religious activities more often tend to disagree even more. Again, in any of the other questions addressed in the survey there was any significant difference between the groups, so that the sample presented here is homogeneous with regard to this assertion as well.

In the construct "conception", the assertions "the crime trend has genetic origin", "only scientists have jurisdiction to decide what should be researched" and "it's impossible to insert animal genes in the plant" were excluded from the final model.

Among the subjects surveyed, 67.7% disagree that the crime has a genetic origin (Table 6), and those who attend a Production Engineering course and have age over 25 years are the ones who most disagree with this assertion.

For the question "only scientists have competence to decide what should be researched", 65.2% disagree, taking into account that those considered spiritualists, those who participate in religious activities more often and those who talk about science with friends tend to disagree even more. Those who attend to Administration less disagree and those with 25 years or more are the surveyed that mostly agree.

In addition, 64.2% of the subjects responded "don't know" in the assertion "it is impossible to insert genes in animal plant", and those with income above $3,000.01 tend to disagree less, showing that it was not a good assertion to measure conception (knowledge). In none of the other questions addressed there was any significant difference between the groups, so that the sample presented can be considered homogeneous with regard to this assertion.

It is noted that the remaining variables for the composition of the "social-factor" refers to the consumption of information broadcast by media. The conversation with friends was eliminated.

The other questions that initially comprised the "social factor" were eliminated since they were related to the consumption of information through the media.

Table 11 shows the incremental adjustment measures and the global model.

Table 11. *Goodness of Fit model measures.*

Measures	Values	Acceptable values
Weighted chi-square	2,128	< 3,0
RMSEA	0,0341	RMSEA < 0,08
GFI	0,981	> 0,9
AGFI	0,975	> 0,9
NFI	0,951	> 0,9
NNFI	0,978	> 0,9
CFI	0,981	> 0,9

All adjustment measures of the model proved to be suitable, as shown in Table 2. To evaluate the unidimensionality of the constructs, we observe if each value in the array of standard residues of each construct is small (less than 2.58, at a significance level of 5 percent). Looking at the value of the CFI, we note that only 1.9% of the residue has value above 2.58, what is appropriate.

To evaluate the internal reliability of each construct, we use the Cronbach´s alpha, which is presented in Table 12. For the calculation of the value of alpha we consider the total sample of 1658 subject.

Table 12. *Cronbach´s Alpha constructs*

Construct	Alpha
Conception	0,628
Attitude	0,667
Social factor	0,810

Through Table 3 we can see that the values of alpha of each measured construct are above 0.6, indicating good adaptation of the measurement model.

4.4. Structural Equation Modeling

On structural equation modeling, the relations of causality were tested between the constructs in five different models: theoretical model, alternative model A, alternative model B, alternative model C and alternative model D.

In this part of the analysis the sample remained in 970 respondents who answered all questions.

For the measurement of each of the constructs were used only the indicators that the confirmatory factor analysis showed to be suitable, as shown in Table 1, and the parameters were estimated using the method of Unweighted Least Squares (ULS).

Table 13 shows the incremental and global adjustment measures for each one of the tested models.

Table 13. *Adjustment settings of each model*

Measures	Theoretical Model	Model A	Model B	Model C	Model D
Weighted chi-square	2,128	6,158	2,126	2,128	2,126
RMSEA	0,0341	0,0730	0,0341	0,0341	0,0341
GFI	0,981	0,912	0,980	0,981	0,980
AGFI	0,975	0,889	0,975	0,975	0,975
NFI	0,951	0,780	0,950	0,951	0,950
NNFI	0,978	0,771	0,977	0,978	0,977
CFI	0,981	0,804	0,980	0,981	0,980

By table 4 we observed that the theoretical model and the alternative model C had the best settings. To decide which one is the best, we analyze the loads of factorials of the structural model and the R2 of both as shown in Table 14.

Table 14. *Assertions related to biotechnology and genetic engineering.*

Model	Endogenous variables	Exogenous variables	Coefficients	t	sig	R2
Theoretical model	Attitude	Conception	0,944	40,207	0,0235	0,864
		Social factor	0,0654	5,312	0,0123	
Alternative model B	Attitude	Conception	0,907	42,338	0,0214	0,723
	Social factor	Conception	- 0,219	-19,176	0,0114	0,0479
Alternative model C	Social	Conception	- 0,656	-3,391	0,193	0,0893
		Attitude	0,438	2,263	0,193	
Alternative model D	Conception	Social factor	-0,219	-26,285	0,0083	0,0479
	Attitude	Conception	0,907	18,560	0,0489	0,723

In the theoretical model, we see that the variance of the endogenous variable (attitude) explained by exogenous variables (conception and social factor) is 86.4% according to the R2 obtained. In models B and D it is 77.1%, and in the alternative model C this variance explained is just 8.93%.

Similarly, the regression coefficients of the model C has not shown to be significant, i.e. they did not present t-values greater than 1.96 considering a significance level of 0.05. Thus, we cannot say that there is an empirical evidence of the relationships among constructs set out in alternative Model C.

On the other hand, the theoretical model presents significant coefficients indicating proof of relations among the established constructs and, according to the value of the CFI, presents only 1.9% of residues with values above 2.58 (considering a significance level of 0.05). In addition, the theoretical model offers greater variance explained than the models B and D.

Figure 3 shows the structural model obtained from the theoretical model.

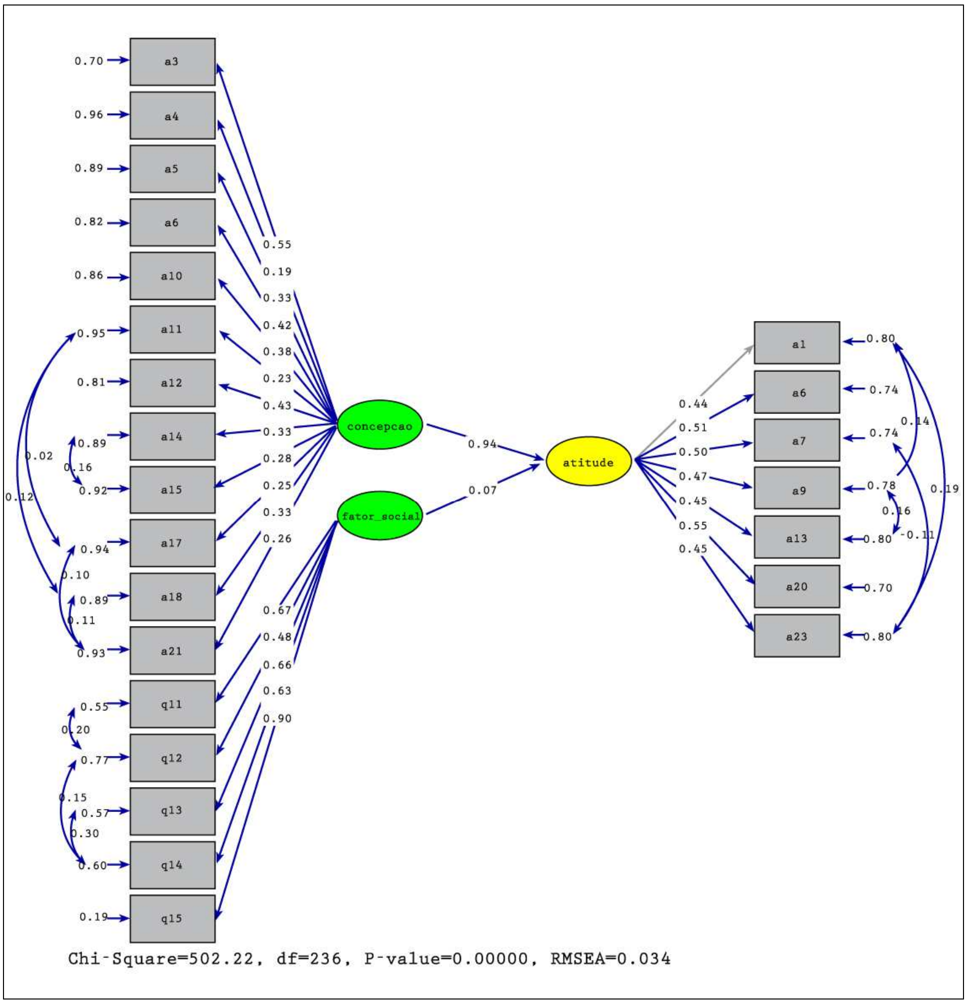

Figure 3. *Structural model obtained from the theoretical model.*

In the model obtained, we checked through the coefficient shown in Table 36 that relations between attitudes and conceptions are positive, that is, the more people agree with the assertions regarding conceptions ("the benefits of genetic engineering are greater than its negative effects", "it is possible to create an organ from stem cells", "genetic research results can be applied to any human being", "it is possible to transplant just a piece of the liver", "more than half of human genes are identical to those of chimpanzees", "in the early months of pregnancy it is possible to know whether the child has any genetic disease", "scientists discover new theories by observing the reality", "the cloning of living creatures produces identical beings", "science learned in school has nothing to do with the everyday life", "the new scientific theories complement old theories", "scientists are extremely strict in the use of the scientific method" and "homosexuality is a genetic trait"), the more people tend to agree with the assertions related to attitudes ("introduce human genes into bacteria to produce drugs or vaccines", "donate blood for scientific research", "use genetic tests to detect diseases such as cancer or neurological disorders before they appear", "allow the creation of embryos for stem cell development", "genetic manipulation of embryos at the request of parents so that their children do not develop genetic diseases", "develop genetically modified animals for purposes of scientific research in the medical field", "introducing human genes in animals to produce human organs for transplant").

The social factor also showed a positive correlation with the attitudes, according to the coefficient of Table 5. However, it is worth mentioning that the option "every day" for the consumption of information was encoded with code 1 for entry into the database. This code is the same as for the option "disagree" of the assertions. In this way, we can say that the more a person has seen, read or heard programs that address science over the past three months, whether on TV, radio, printed magazine or newspaper or internet, the more the person tends to disagree with the assertions related to attitudes.

Thus, we can say that the media has provided a base to make people more critical with respect to the development of genetic engineering.

5. Final Considerations

In this study, our goal was to verify, with statistical reliability, whether there is any causal link or dependency between the conceptions people have about science and their attitudes in front of it, mediated by some social indicators.

In this way, for the completion of the survey, we made a bibliographical review about the ideas that people have about the science, their attitudes in front of it and the social indicators that could have some impact in this relationship. With that, we were able to develop a theoretical model that represents relations between "conceptions", "attitudes" and "social factors". We also made four alternative models to compare with the theoretical model.

To test and evaluate these models, it was built a research instrument consisting of fifteen assertions regarding "construct" conception, nine probes pertaining to "attitudes" and seventeen questions (open and closed) that would measure the "social factor".

Through confirmatory factor analysis, there were eliminated three assertions of the construct "conception", leaving the assertive: “the benefits of genetic engineering are greater than its negative effects”, “it is possible to create an organ from stem cells”, “genetic research results can be applied to any human being”, “it is possible to transplant just a piece of the liver”, “more than half of human genes are identical to those of chimpanzees”, “in the early months of pregnancy it is possible to know whether the child has any genetic disease”, “scientists discover new theories by observing the reality”, “the cloning of living creatures produces identical beings”, “science learned in school has nothing to do with the day to day”, “the new scientific theories complement old theories”, “scientists are extremely strict in the use of the scientific method” and “homosexuality is a genetic trait”. Once the adjustment indicators of measurement proved to be suitable, as well as the value of Cronbach's Alpha for this construct, we can conclude that the indicators mentioned above actually measure the construct "conception".

In addition, we conclude that the assertions “introduce human genes into a bacterium to produce pills or vaccines (e.g. insulin for diabetics)”, “donat blood (or genetic material) for scientific research”, “use genetic tests to detect diseases such as cancer or neurological disorders before they appear”, “allow the creation of embryos for stem cell development”, “genetic manipulation of embryos at the request of parents so that their children do not develop genetic diseases”, “develop genetically modified animals for purposes of scientific research in the medical field” and “introducing human genes in animals to produce human organs for transplant” are sufficient to measure the construct "attitudes", since both the Cronbach's Alpha and the measures of adjustment model of measurement were suitable for this construct.

The social factor was restricted to matters relating to the consumption of science information conveyed by the media: TV, radio, magazine and newspaper (print and internet). However, this factor also showed a good fit and an alpha value of 0.810.

Analyzing the structural model obtained, we conclude that the beliefs that people have about the science and genetic engineering has a high impact on their attitudes against genetic engineering. The impact of the social factor is significantly lower, although still important.

In this way, we can conclude that there is a linear dependence between attitude vis-à-vis the science and conceptions, which can send us the deficit model. However, in this model, the rated construct is only the scientific knowledge in the sense of "accumulation of knowledge encoded and certified as true" (Vogtand Polino, 2003), setting aside controversial questions. What we measure as conception in this work includes some assertions relating to knowledge, but most refers to beliefs about science and genetic engineering present in the social imaginary (which cannot be classified as true or false). Thus, a concordance with the beliefs presented refers us to more favorable attitudes to the development of genetic engineering.

We also noted that 65.2% of the subjects surveyed disagree that only scientists have competence to decide what should be researched. They believe that people should participate in decisions about which topics should be researched, helping to select the goals and development of researches.

The media types covered in this research (internet, TV, magazine, newspaper and radio) differ from the textbooks used in schools as the "frontier science" which is still settling, making a bridge between the scientific community and the public at large, especially with regard to recent scientific discoveries.

In this sense, the consumption of information about science through the media (social factor) reveals that, as the consumption gets higher, more critical and cautious citizens become with respect to the development of genetic engineering. In the deficit model occurs precisely the opposite: the public resistance to certain breakthroughs of science is based on ignorance, superstition and fear, having no influence of personal values. Thus, in this model, it is believed that the knowledge of science encourages more positive attitudes.

However, what we see seems to go against the deficit model, that is, the more the person consumes information about science and, therefore, we imagine, the more the person knows, he/she becomes more cautious with regard to the advancement of science, perhaps due to the lack of a cultural stereotype positive for science.

On the other hand, when we assess the frequency with which the subjects talk about science with friends, we observe that those who talk most often have more favorable attitudes, since they tend to agree more in donate their bloods (or genetic material) for scientific research, to use genetic tests to detect diseases before they appear, in introducing human genes into a bacterium to produce pills and that it is possible to create an organ from stem cells. Those who usually comment about science with friends tend to disagree more about the introduction of human genes in animals to produce human organs for transplant and in relation to the development of genetically modified animals for purposes of scientific research in the medical field.

Despite the questions relating to religion have not been included in the structural model, we find that they are important in the separation of attitudes towards science. We found that most evangelicals disagree with the development of genetically modified animals for scientific research purposes, that homosexuality is genetic, that more than half of human genes are identical to those of chimpanzees and that the cloning of living organisms produces identical beings. Also, they tend to agree less with the use of genetic tests to detect diseases before they appear, with the introduction of human genes into bacteria to produce drugs or vaccines, with the creation of embryos for stem cell development and that in the early months of pregnancy it is possible to know whether the child has any genetic disease or not.

In addition, those who consider themselves religious tend to disagree more in introducing human genes in animals to produce human organs for transplant and in developing genetically modified animals for purposes of scientific research in the medical field. On the other hand, those who do not consider themselves religious tend to agree more with the use of genetic manipulation of embryos so that their kids don't develop genetic diseases, are favorable in introducing human genes into a bacterium to produce pills, allow the creation of embryos for stem cell development and that it is possible to create an organ from these.

Those who participate in religious activities more often tend to disagree more in introducing human genes in animals to produce human organs for transplant, in using genetic manipulation of embryos for their kids to have certain physical characteristics and that homosexuality is a genetic trait. Also tend to disagree more on development of genetically modified animals for purposes of scientific research in the medical field.

So, in our analysis, those who are evangelicals or consider themselves religious persons or participate more often of religious activities have attitudes less favorable towards the development of genetic engineering, corroborating the idea of Nisbet et al. (2007), in which it is expected that to attend the religious programs is referenced in a negative way with the attitudes toward genetic engineering.

In relation to personal experiences, we find that those who have a relative with a genetic disease tend to agree more in donate their bloods for genetic research. In addition, the group that owns a family member or friend that had to do a transplant tends to agree more that in the early months of pregnancy it is possible to know whether the child has any genetic disease or not and also donate their bloods (or genetic material) for scientific research. In this way, the experiences may be indicative of separation between some attitudes.

In addition to these, gender also seems to be an indicative variable of separation, since we find that men have more favorable attitudes; they tend to agree more with the use of genetic tests to detect diseases before they appear, with introducing human genes into a bacterium to produce pills and with the creation of embryos for stem cell development.

Regarding to the income, we observed that the higher a person's income, the more favorable is the attitude of this person towards science, because those with income exceeding R$5,000.01 tend to agree more than whether to allow the creation of embryos for stem cell development, to donate their bloods (or genetic material) for scientific researches, in introducing human genes into a bacterium to produce pills or vaccines and that the science learned in school is related to the day by day. Also, they tend to disagree less in relation to the development of genetically modified animals for purposes of scientific research in the medical field.

The variables ages, courses, years of admission, and perceptions of knowledge seem to be more related to beliefs (more specifically to knowledge) than to attitudes, since the differences found between the groups in these variables focus on knowledge-related assets, not attitudes.

Thus, we concluded there is a causal link between conceptions and attitudes and between social factor and attitudes. However, we cannot highlight the contribution of the social factor (media), especially when they are addressed controversial topics that are not taught in school.

The media have a major responsibility as a source of information and opinions former about science for citizens, not only for its persuasive effects, but also via the relationship between entertainment and social identity, mediating a set of social relations. In this way, the communication of science should not be summed up in pass knowledge to the lay public, but cease to be focusing on knowledge itself and be directed to the needs of the public, taking into account the social context.

The results obtained in this research can contribute to the development of indicators of public perception of science in Brazil, in addition to providing subsidies to carry out effective changes in the educational system so that the population can make decisions about scientific questions of social character. In this sense, public educational policies should no longer be aimed as a "correction" of "the cognitive deficit".

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