Construction and validation of a questionnaire for the analysis of bioethical conceptions

Paloma Rodrigues da Silva [1], Elaine S. N. Nabuco de Araújo [2], Ana Maria de Andrade Caldeira [3], Graça S. Carvalho [4]

Abstract

In this paper we describe the stages of a quantitative questionnaire development that allows the investigation of conceptions about bioethical values inherent to the scientific activity. This questionnaire was statistically and semantically validated and developed according to the Likert scale. The relevance of this instrument is given by the fact that, unlike what happens in European countries, quantitative research in Brazil has little educational traditions. Therefore, this work is intended to subsidize the use of quantitative methods in Education research that lack such tools.

Key words: Education. Bioethics. Methodology.

Resumo

Construção e validação de questionário para análise de concepções bioéticas

Neste artigo objetivamos descrever as etapas do processo de elaboração de um questionário quantitativo que permita investigar as concepções sobre valores bioéticos inerentes à atividade científica. Validado semântica e estatisticamente, o questionário foi desenvolvido tendo por base a escala do tipo Likert. A relevância deste instrumento se dá pelo fato de que, diferentemente do que ocorre nos países europeus, as pesquisas quantitativas educacionais no Brasil têm pouca tradição. Este trabalho destina-se, portanto, a subsidiar o uso de métodos quantitativos nas pesquisas em Educação, que carecem de instrumentos deste tipo.

Palavras-chave: Ensino. Bioética. Metodologia.

Resumen

Construcción y validación de un cuestionario para análisis de concepciones bioéticas

En este trabajo se describen las etapas del desarrollo de un cuestionario cuantitativo que permite investigar las concepciones acerca de los valores bioéticos inherentes a la actividad científica. Este cuestionario fue validado estadísticamente y semánticamente, y fue desarrollado tomando como base la escala de Likert. La relevancia de este instrumento está dada por el hecho de que, a diferencia de lo que ocurre en los países europeos, la investigación cuantitativa en Brasil tiene poca tradición educativa. Este trabajo tiene por objeto, por tanto, subsidiar el uso de los métodos cuantitativos en la investigación en educación, que carecen de tales herramientas.

Palabras-clave: Educación. Bioética. Metodología.

Research article

1. Attending doctor's degree paloma.bio@hotmail.com – Universidade Estadual Paulista, Bauru/SP. **2. Doctor** enabuco@netsite.com.br – Universidade Estadual Paulista, Bauru/SP. **3. Doctor** anacaldeira@fc.unesp.br – Universidade Estadual Paulista, Bauru/SP. **4. Doctor** graca@ie.uminho.pt – Universidade do Minho, Braga, Portugal.

Mailing address
Paloma Rodrigues da Silva – Rua Joaquim Marques de Figueiredo 14-55, casa 103, Distrito Industrial Domingos Biancardi CEP 17034-290. Bauru/SP, Brazil.

They declare that there is no conflicts of interest.

As a result of the intense scientific and technologic production in the field of biology, biologists and teachers are more and more dealing with bioethical issues related to conflicts between the new biological knowledge and its biotechnological applications and the ethical values present in society. Currently, discussions on these conflicts are evidenced when we consider the amount of recent papers on the subject. Such papers generally constitute qualitative studies and the data collection happens mainly during individual interviews or semi-structured questionnaires, that is, with the possibility of open answers. However, we feel it is also necessary the development of quantitative researches in the area, once the *statistic procedures back up considerably the conclusions obtained* [1], for they present reasonable degrees of precision, which makes them well accepted among researchers.

Due to the absence of a data collection instrument that allows to investigate how future Biologic Sciences Teachers perceive the relation between values and science and also their bioethics perspectives in front of a conflicting situation between science values, our goal is to develop a quantitative instrument that can be validated and produced effective results, aimed at the conduction of researches that raise bioethical conceptions and values in the scientific activity. In this paper we describe the theoretic methodological basis of this analytical process aiming to broaden the use of quantitative methods in Education research.

The structure of the questionnaire

As a data collection instrument, we chose the construction of a Likert scale. Basically, this scale consists on a series of affirmations in which the respondent must express his/her degree of agreement or disagreement of each sentence, and every position represents a numerical value [2].

For this instrument we used a scale with four variants: 1) Strongly agree; 2) Agree; 3) Disagree; 4) strongly disagree. We chose to remove the central alternative "don't agree or disagree", present in the majority of researches using this scale, in order to avoid the central tendency in the answers. The removal of this option has also been advocated by many authors, considering its interpretation to be very ambiguous by the interviewer, for it can indicate a lack of opinion on the matter or indecision upon the affirmative [3]. In order to minimize this double interpretation, we chose to remove the central alternative.

This scale has a series of advantages, such as provide directions on the conception of the respondent regarding each item in the instrument and the non-ambiguity of the answer categories which, for being previously determined, avoid the respondents to create answers that might hamper the researcher's interpretation.

Affirmation's formulation

After defining the structure of the questionnaire, the next step to the construction of the instrument was to determine the theoretical reference to be used. The structures and bases were selected, which enabled the creation of affirmations capable of relating the respondent's conception of science and how they understand the influences of ethical and moral values in the scientific activity. These discussions are intimately related, for to be capable of accomplish effectively the discussion on the applicability and the development of new technologies it is important to have the values that influence the scientific activity clear. Distorted science conceptions, that is, conceptions free of critical reflections and connected to presumptions such as the Salvationism, essentialism, neutrality, autonomy, impartiality and reductionism (which will be discussed later in this article) can lead to unthought-of and inconsequent decisions, many times ignoring the basic principles of bioethics. The theoretical reference made it possible the development of an instrument divided into two parts: the first is composed of questions related to the bioethical and scientific perspectives of the respondents; the second refers to respondents' personal data, such as age, gender, religion and education.

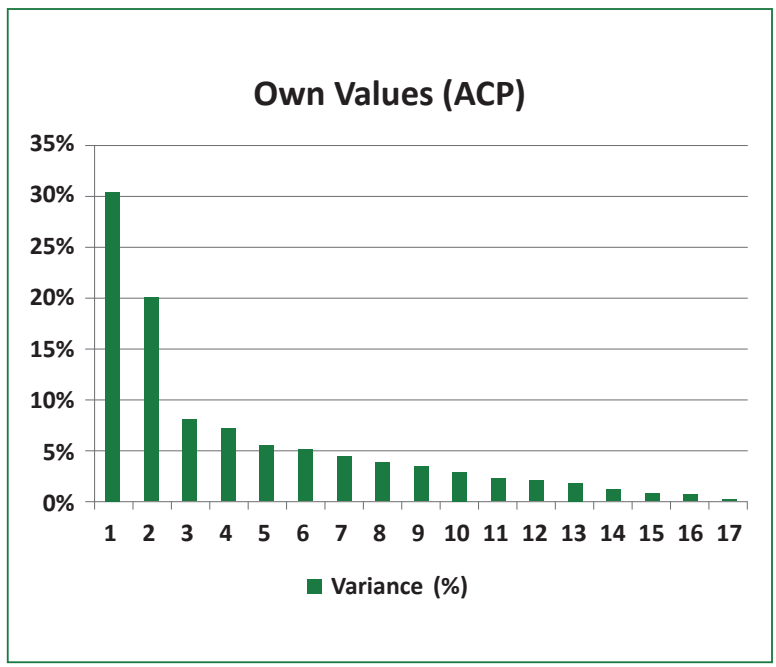
The affirmations present in the first part of the instrument are based in two central themes: one, composed by affirmations focused in understanding how the respondents comprehend the *influences of ethical values in the scientific activity*. This theme opposes a favorable position to the influence of ethical and moral values in the scientific activity, a science contrary to the influence of ethical and moral values in the scientific activity; the other works with the respondent's conceptions of science, and opposes a mistaken conception of the scientific activity (that is, free of critical reflections) to a less distorted conception of science.

The central themes

The central themes of the questionnaire were established through a multivariate analysis: The goal of the multivariate analysis is to measure, explain and predict the degree of relation between the statistic variables (pondered combinations of variables). This way the multivariate character consists of multiple statistic variables (multiple combinations of variables) and not only a number of variables or observations [4].

Among the analysis techniques we chose to conduct the Principal Component Analysis (PCA). The PCA of the set of variables provides two axles (Component 1 and Component 2) that present important proportions of the variety of answers. These axles are represented in the histogram of proper values (Figure 1).

Figure 1. Histogram of proper values, presenting the part of variance to which each PCA component refers. The two first axles are the most important.



The most accentuated concept guidance characterize Component 1 (C1), represented by the most elevated bar in Figure 1, and composes the horizontal axle of Figure 2. This is the component that has the biggest variance between the interviewed individuals.

Figure 2. Chart of correlation of variables analyzing the meaning of the space defined by the main axles (two main components of PCA). The affirmations in red have a greater representativeness in Component 1 and the ones in green, a greater representativeness in Component 2.

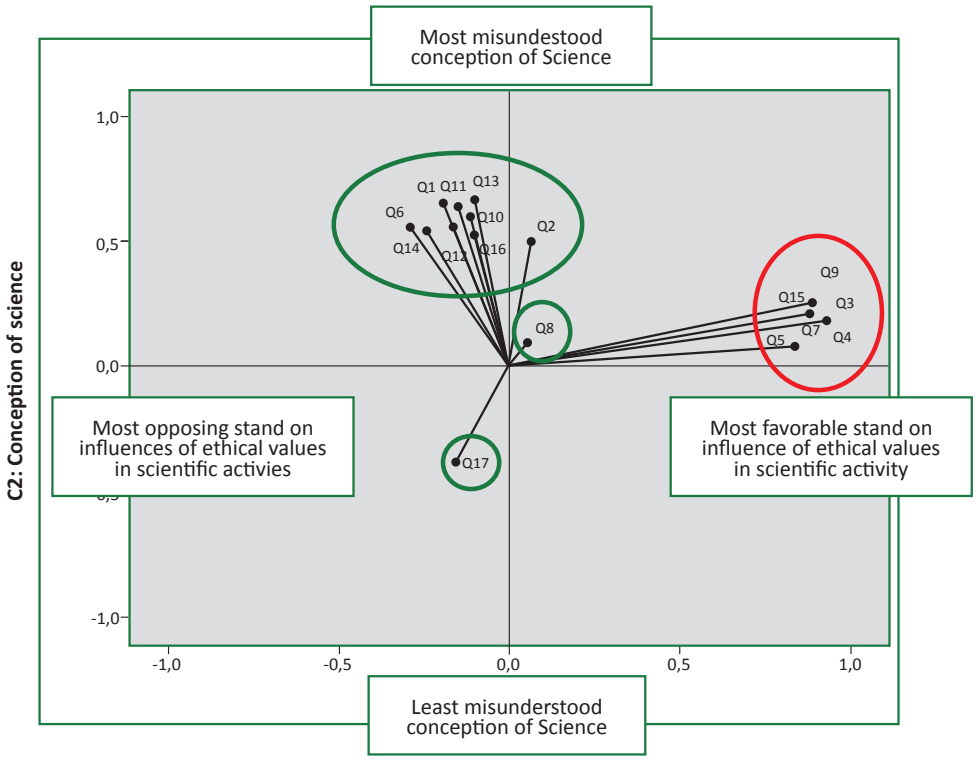


Figure 2, named Correlation Chart, shows the variables represented in the plane (C1, C2). The projection of the variable's coordinates over the axles allows recognizing the affirmations that characterize these axles. The variable vector whose projection in the axle has the highest value is more connected to that axle than the others. From the analysis of these graphic representations the conceptive orientations that characterize both axles can be identified.

These analyses were conducted using the statistic program *Statistical Packet for Social Sciences* (SPSS®), version 20. The graphical analysis allows to verify that the affirmations Q3, Q4, Q5, Q7, Q9 and Q15 (circled in red) have a greater representativeness in Component 1 (axle X) that in Component 2 (axle Y). In parallel, affirmations Q1, Q2, Q6, Q8, Q10, Q11, Q12, Q13, Q14, Q16, Q17 (circled in green) have a greater contribution in Component 2 (axle Y) that in Component 1 (axle X). From the content of these affirmations, Component 1 was named *influence of ethical values in the scientific activity*. Component 2 deals with respondent's *conception of science*. Chart 1, below, shows affirmations Q3, Q5, Q6, Q8, Q9 and Q15, composing Component 1.

3.	The ethical and moral values of society shouldn't interfere in researches using embryonic stem cells.	Strongly agree	Strongly disagree
5.	Opinions based in moral values are not relevant in discussions involving the use of embryonic stem cells in therapeutic researches.	Strongly agree	Strongly disagree
6.	I am favorable to the creation of an ethical and moral conduct code related to biotechnological issues.	Strongly agree	Strongly disagree
8.	There is no room for ethics in science, for scientists must be autonomous.	Strongly agree	Strongly disagree
9.	The ethical and moral values of society should interfere in the scientific and technologic development.	Strongly agree	Strongly disagree
15.	Scientist's work is not influenced by social values.	Strongly agree	Strongly disagree

The affirmations concerning this theme aim to establish relations between the Hugh Lacey's [5] perspective of autonomy in science and the ethical aspects that arise from the scientific and technological development. This way the affirmations of the instrument composing this axle were based in the presumptions of autonomy and impartiality proposed by Lacey of principles that form the current of principialism in bioethics and the principle of precaution.

In *Is Science Value Free?: Values and Scientific Understanding,* Lacey [5] presents three theses (idealized) that base the conception that values (except for cognitive) do not influence scientific activities. They are: impartiality, neutrality and autonomy. The neutrality idea was used as theoretical basis for the affirmations forming Component 2 of the questionnaire, and will be discussed later. In turn, the impartiality and autonomy theses were used in the creation of the affirmations forming Component 1 of the questionnaire, and can be understood as:

Impartiality is the conception that theories are correctly accepted in virtue of manifesting high cognitive values, according to the most rigorous evaluation standards and related to an appropriate series of empiric data. Although I do not present here the details of this conception, I must observe that impartiality implies in serving determined values or be consistent with the presumptions of the scheme of a particular values is irrelevant to the legitimate acceptance of a theory [5].

Thus, the argument of impartiality defends that the scientific decisions be made supported only in cognitive criteria, with methodological rigor, precision, clarity, etc. The scientific activity involves basically three moments: 1) Choice of strategies; 2) Evaluation of theories; and 3) Decision on the applications. To Lacey, the presumption of impartiality can be checked in the second moment, that is, in the moment where the theories are being accepted or denied. According to the author, given that the social and ethical values do not present a legitimate role in moment 2, it is possible to obtain the impartiality. However, despite the importance of the impartiality, it is not sufficient to obtain neutrality, which acts on levels 1 and 3.

(...) only appropriate empiric data and cognitive criteria (epistemic) must be relevant to assess the confirmation of scientific theories and hypothesis and it is assumed that this criteria does not allow any role to the ethical and social values or the interest of the powerful [6].

The presumption of autonomy proposes, initially, the distinction between the basic and applied scientific research. According to that conception, the basic research, because of its goal of knowledge through knowledge is free of the concern of how this knowledge will be applied. Besides, it must be sponsored by autonomous institutions, which have no interference in the production of such knowledge.

The basic principles that compose the current of principialism in bioethics were also used to create the affirmations present in Component 1 of this questionnaire. They are: respect for autonomy, justice, beneficence and non-maleficence. The respect for autonomy demands, at least, that the individual has the right to: 1) *his/her own point of view*; 2) *make his/her own decisions and*; 3) *act accordingly to his/her personal values and beliefs* [7]. The concept of justice can be understood as the concept of equality, for equal people have the right to receive equal treatment. The concept of beneficence basically refers to the moral obligation to act in the behalf of others; at last, the concept on non-maleficence is understood as the *obligation not to cause intentional harm* [7] or, even, the obligation to avoid harm.

Besides these four principles that integrate the current of principialism in bioethics from its conception, others can be added in discussions with a bioethical approach. Among them we stress the principle of precaution. Lacey [6] argues in his works that the techno scientific innovations are always associated with risks. Therefore, precautions must be taken so that the damages can be minimal. According to the author, the principle of precaution can be understood as an act of caution related to the applications of scientific and technologic knowledge produced. He foresees the incorporation of ethical values in the scientific development, assessing the social and environmental risks that can occur from certain activities.

Chart 2, bellow, shows affirmations Q1, Q2, Q6, Q8, Q10, Q11, Q12, Q13, Q14, Q16, Q17, approaching the respondent's conceptions of science. The affirmations that form this axle can be discussed both with the support of the presumptions of neutrality, Salvationism, essentiality and reductionism and the aforementioned bioethical principles.

1.	I consider the use of embryonic stem cells in therapeutic researches to be essential.	Strongly agree	Strongly disagree
2.	I believe that by labeling the transgenic food and giving the opportunity for the population to choose to eat it or not, we solve the ethical problems surrounding this subject.	Strongly agree	Strongly disagree
6.	The techniques of genetic manipulation are developed to improve life quality.	Strongly agree	Strongly disagree
8.	No technology is good or bad, it all depends on its use [8].	Strongly agree	Strongly disagree
10.	Recent therapeutic cloning techniques will assure the cure of many diseases.	Strongly agree	Strongly disagree
11.	Scientific development generates social development.	Strongly agree	Strongly disagree
12.	I'm favorable to therapeutic cloning in order to produce organs and stem cells.	Strongly agree	Strongly disagree
13.	Studies with embryonic stem cells will create new therapies that will diminish the suffering of patients with incurable diseases.	Strongly agree	Strongly disagree
14.	I am pleased by the idea of in vitro fertilization techniques with selection of pre-embryos can, in the future, allow people to choose physical and intellectual characteristics of their children.	Strongly agree	Strongly disagree
16.	In case there is a human immune to emerging diseases, I am favorable to cloning this individual.	Strongly agree	Strongly disagree
17.	I am pleased by the idea of selecting pre-embryos before transferring it to the mother uterus in vitro fertilization clinics, because it allows the elimination of unwanted characteristics.	Strongly agree	Strongly disagree

The affirmations that form this axle aim to establish a connection between values and scientific activities. In order to create the instrument, fundaments of papers by other authors were used [5,8-14] which discuss the issue of influence of values in the scientific activity. The presumptions used in the creation of these affirmations were, mainly, neutrality, Salvationism, essentiality and reductionism.

The idea of neutrality, along with the ideas of impartiality and autonomy, previously mentioned, composes the traditional science perspective and can be understood such as: *The neutrality established that the other theories don't imply any statement on values and, at first, can be adopted in practices conducted inside any value scheme; besides, the acceptance of a theory has no implication on the fundamental values adopted* [5]. In this perspective, science is held as something disconnected from social and cultural values, not taking sides and not serving any specific interest. By accepting these three principles (autonomy, impartiality and neutrality) we assume the production of a scientific knowledge completely free of social values.

Despite the discussion that the values have influence in the scientific activities [15], we considered pertinent to stress that this does not mean to defend that the theoretic products resulting from such activities don't have the correct cognitive credentials. According to Lacey [5], the cognitive values have an essential role n the moment of theory acceptance. But, as the social values have a central importance (and legitimate) in the scientific activities, his proposal is based in expanding the variety of values influencing the moment of choice of scientific strategies, aiming to mitigate the importance of those already present [16].

The conception of Lacey proposes a science immerse in a social and historical context, since it is developed by individuals integrating a cultural reality. Seeing the scientific activity as free from such values is immersing in a reductionist conception that accepts all that is "scientifically prove" as "true". To the author, from the 17th century on, the understanding that puts science as part of the human heritage was developed. However, recent environmental crisis, military scientific development and science's subordination to economical interests lead us to question the real contribution of science to the welfare of the human being and to maintain the ethical values.

Papers discussing the subject [11-13] have concluded that the conception of science free of values and supported in the perspectives of impartiality, neutrality and autonomy can lead to the development on other mistaken conceptions. Among them are the Salvationism, essentiality and reductionism.

Auler and Delizoicov [11] discuss that, according to the Salvationist perspective, science and technology (ST) are always developed to solve the humanity's problems. It is noticeable in this conception the rooted linear interpretation of progress, that is, that the scientific development promotes the techno-

logical development, which implies in the economical development, which would consequently lead to the social development. However, ST's development cannot be considered free of values and political and economical interests.

Because it understands that science is necessarily developed to solve society's problems and improve life quality, the Salvationist conception of science leads to an essentialist perspective. Essentiality predicts that scientific work is absolutely necessary and indispensable to the survival of mankind. Bazzo *et al.* [13] discuss the essentiality, pointing it as the result of the linear model of development, which postulates that the social welfare is an automatic consequence of scientific progress. This way, science is held as something essential so there is social welfare. The solutions to the economical, political, environmental, etc. problems would inevitably elapse from a simple increase of scientific and technological production.

To Auler and Delizoicov [11] these perspectives that do not consider science to be a part of a cultural set, being influenced by the historical period it is inserted, are fairly reduced, for they ignore the fact that the scientific activity is practiced by individuals immerse in a social context. In the same paper, they present an interesting discussion about the conceptions of scientific and technologic development: the reductionist and amplified conception.

The reductionist, in our analysis, does not considerate the existence of constructions sub adjacent to the production of scientific and technologic knowledge, such as the one that leads to a conception of neutrality of Science-Technology. The broaden perspective (...) aims the understanding of the interactions between Science-Technology-Society (STC), associating the teaching of concepts to the problematic of these myths [11].

To the authors [11], it is expected that citizens are capable of actively participate on ST decisions, in a democratic way, questioning the dominant ideology of the technological development. However, for that to occur, it is necessary for the individuals to develop an amplified conception of the scientific development, not being limited to the simplism observed in the reductionist conception. We understand that the diversity of new comprehensions about the nature of science is essential to beacon the choices of the individuals. Accepting science as "absolute truth" and as the only true knowledge is to dive into a reductionist perspective, since science is not the sovereign source of unquestionable knowledge.

Justification of affirmations

We can discuss the affirmation Q1 relating it basically to four presumptions: essentiality, neutrality, justice and non-maleficence. We understand that it is implicit in this affirmation the idea that the use of embryonic stem cells is inherent to the development of researches in the field. We stress that we know the importance of said studies, for many recent researches in the area of genetic manipulation have indicated positive results related to the treatment of many diseases we now consider incurable. However, the study with adult stem cells has also been very promising.

In this way, we can also think about the presumption of neutrality. Lacey [6] states that the *commitment to neutrality requires, from the scientific community as a whole, the adoption of a diversity of strategies*. In other words, to reach neutrality it is necessary to be a diversity of methods and a broadening of scientific practices. To the author, without a diversity of methods there is no possibility of science to deal with all questions relevant to society as a whole, since some values are privileged over others. The path through which science is being led does not easily fit with neutrality; it serves well the values of capital and market, but not the ones of sustainability [6].

In 2007, two teams of researchers, American and Japanese, published in Magazines *Science* and *Cell,* respectively, accounts on the production of stem cells equivalent to the embryonic ones from adult epithelial cells. Studies like these show the possible alternatives to the use of embryos, which can reduce the ethical issues revolving the subject in the future.

We will discuss the affirmation Q2, which deals with the issue of transgenic food, with the support of the presumptions of reductionism, principialism based autonomy and the principle of precaution. In this affirmation, all ethical problems revolving the issue of transgenic food (economical, environmental, medical, etc.) are reduced only to labeling. Agreeing to this affirmation indicates that the respondent considered in his/her answer only the aspects related to the right of production of transgenic products and the right of the consumer to be informed. We stress that not labeling products directly violates the basic principle of autonomy. The non-labeling prevents the population to know what is being consumed, that is, prevents individuals from making their own choices and acting according to their beliefs.

In 2003, the Decree 4.680/03 created the "transgenic" symbol. According to the decree, all and any food and ingredient that has or is produced from genetically modified organisms, with presence above 1%, needs to be labeled. This initiative, although representing a big advance, does not end the issues related to labeling. Not only do we need to obligate producers to label their products, we need to ensure that the population understands the meaning of this symbol. Without the consumer's comprehension, the principle of autonomy is still violated, because individuals can't make their choices consciously.

There is no doubt that the ethical and social values are essential to the decisions on the applications of knowledge and the scientific methods. However, Lacey [16] states that, in general, the techno scientific research is led according to the following principle: *Usually, unless there is strong scientific evidence that there are serious risks, it is legitimate to implement – without delay – effective applications of objectively proved scientific knowledge.* This presumption has implications on the priorities of scientific research other than the principle of precaution. However, we understand that the deliberations on the application and commercialization of transgenic food cannot be detached from society's ethical standards, such as the protection of human rights.

As previously stated, affirmations Q3, Q4, Q5, Q7, Q9 and Q15 can be discussed based on the presumptions of autonomy and impartiality, proposed by Lacey, and the principles that form the current of principialism in bioethics. The 6 affirmations allow us to reflect it the ethical principles, such as justice, autonomy, beneficence, non-maleficence and precaution can interfere in researches using embryonic stem cells, for instance.

We stress that there is no doubt that ethical, and also social, values are essential to the deliberations on the application and development of scientific knowledge. Lacey's epistemology discusses that social and ethical values are often on the table in the beginning of researches, influencing the priorities and even the methodological approaches adopted, even though the traditional conception of science preaches the contrary – defending, thus, the idea of neutral science. This influence, contrary to beliefs, is legitimate and contributes to build the desired neutrality, since the diversity of values considered to the scientific development is broadened.

Affirmation Q6 can be seen either from the Salvationist and neutrality perspective or the principle of precaution. Here the scientific development is seen as something developed only to improve population's life quality, that is, the economic interests behind the development of some genetic manipulation techniques are ignored. When thinking of the genetic manipulation techniques from a neutral and Salvationist perspective, it is possible that the individual develops a tendency to ignore the principle of precaution, since thinking only about the benefits that these techniques can bring, one can ignore the risks attached to them.

Affirmation Q8 deals with presumption of neutrality. In this question, science is seen as something "above good and evil", that is, the discussions must be focused on the products of scientific activity – and not science itself. Bear in mind that the scientific activity basically involves three moments: 1) Choice of strategies; 2) Evaluation of theories; and 3) Decision on the applications. To Lacey, the social and ethical values have no legitimate role, except in moment 2, which makes the principle of impartiality possible. However, despite the importance of impartiality, it is not sufficient to obtain neutrality, which acts on levels 1 and 3. This way we infer that, to agree with this affirmation is to present a strong influence of a neutral conception of science and the respondent considers only the use of products of such activity.

As well as Q6, affirmation Q10 deals with the presumption of Salvationism, since we intrinsically see the idea of linear development of progress. We stress that in no moment did we deny the importance and potentiality of such researches. However there are other dimensions to be considered.

Lacey [16] discusses that researches with stem cells evoke hope that many diseases currently considered incurable can be cured or have its effects reduced. Many promises were made by the scientific community and there was a great repercussion of it in the media. However it is undeniable that there has been much exaggeration. Despite all the excitement, no scientist hopes (or should hope) that applicable treatments be developed in short term. It is understood that, by agreeing with this affirmation, the respondent ignores that, despite the importance, cloning techniques alone will not assure the cure of diseases, due to other factors – social, political and economic, for instance – that should be considered.

Affirmation Q11 also deals with the presumption of Salvationism and clearly exposes the linear conception of progress. Again, we stress that the scientific development is essential to social development (especially in developed countries), but science progress alone won't assure a better life quality to the population.

Affirmation Q12 will be discussed based on the presumption of Salvationism and the principle of precaution. As mentioned in previous affirmations, the importance and potential of researches involving therapeutic cloning techniques is not denied. However, it is not possible to ignore the ethical principles involved in these researches:

Those who propose ethical restrictions to embryonic stem cell researches don't need to oppose the legitimate techno scientific progress. However, they refute the extension in which urgent problems, connected to the human welfare, are open to techno scientific solutions and only them, thus, they refute the immediate legitimacy usually granted to the implementation of techno scientific innovations. They also refute the ethic imperative presumption of prioritizing techno scientific solutions, besides the insinuation that it would be an ethical deficiency to doubt the legitimacy of researches that might lead to solutions. This challenge is not opposed to science and may not even be based immediately in concerns with embryos' rights. Techno scientific research can be conducted under the aegis of the "principle of precaution". That recommends postponing the implantation of techno scientific innovations – and possibly researches that produce them – while additional empiric researches are being conducted regarding their potential risks and alternatives that do not involve the same kind of risk [16].

It is understood that, by agreeing with this affirmation, the respondent is not necessarily ignoring the ethical principles involving the issue and may even not be demonstrating a Salvationist perspective. However, the conception that human welfare will come only from scientific and technologic advances is considered problematic and mistaken. In other words, we understand it is not desirable that individuals be favorable to therapeutic cloning techniques if they understand it will solve all social problems.

The perspective present in affirmation Q13 is similar to question Q10. Here, another issue deals with the Salvationist perspective, in which the recent genetic manipulation techniques are put as assurance to the cure of diseases of the population. As well as in previous affirmations, by agreeing with it, the respondent is considering the scientific development alone is sufficient to "save" population of its diseases

Affirmation Q14 can be considered both from the reductionism perspective and the criteria of justice and non-maleficence. The reductionism perspective consists of the fact that the concordance with this affirmation suggests that the respondent does not consider the social consequences of this selections, such as the increase of the difference between the richer and the poorer, the amplification of prejudice, the economic interests behind the selections, and so on. The discussion of the moment life begins can also be resumed, as started in Q1, to consider the question. Many people understand that embryos are living human beings and, so, have human rights. This way, the right to life (principle of justice) of the embryos that weren't selected is being violated, as well as, of course, the principle of non-maleficence is not being carried out.

Affirmation Q16 can be analyzed from the Salvationist and reductionist perspectives. The implied idea in this question is that "all is allowed if for a greater good". Agreeing to it means the respondent is ignoring the possible consequences of this technique, such as, for instance, the loss of genetic variability of the population – and the loss of individuality, with a possible depersonalization of people. It cannot be ignored that reproductive cloning is a "dangerous knowledge" with associated risks (the ending of sheep Dolly's case reinforces that position). That way it constitutes a great example of application to the precaution principle.

Affirmation Q17 meets Q14. In both cases the idea of artificial selection was mentioned, that is to say, techniques that select individuals with desirable characteristics. As in Q14, agreeing with this affirmation does not consider the social consequences that this selection might generate, such, as mentioned before, the increase of social discrepancy, prejudice and others.

This affirmation also resumes the discussion about the moment in which life begins. If embryos are considered human, the elimination of those with undesired characteristics would violate the principles of non-maleficence and justice. Besides, we cannot ignore that what would be considered "undesirable" to one culture is not necessarily to another.

This way, we understand that the comprehension in society is diverse, with different values diverging from one culture to another, is the basis for the decision-making when dealing with bioethics dilemmas present in social life.

Validation of the questionnaire

After its elaboration, the instrument went through a process of validation, aiming to increase its degree of trustworthiness, improve comprehension of affirmations and eliminate d possible errors.

This process occurred in two steps – semantic and statistic validation.

Cunha [17] stresses the importance of validating the semantics of the instrument before applying it, for if this instrument is incoherent and confusing its analysis can be hurt. Besides, it is important that the language used in the instrument is close to the language of respondents, avoiding misunderstandings of affirmations.

Two groups of individuals were selected to validate the instrument. One was composed of three experts in the area of Science Education; the other, of three possible respondents, that is, individuals with characteristics similar to those in the samples to be used. Both the experts and the possible respondents were selected due to the easy access to these people.

After the changes to the phrasal construction to eliminate the ambiguities suggested by the experts and possible respondents, the instrument was applied in the samples of the pilot-study. After this procedure, the instrument went through the second step of the validation process, which consists in the application of the questionnaire in a small sample (fifteen individuals) identical to the sample of the main study, which data were subjected to alpha tests in Cronbach, Kaiser-Meyer-Olkin (KMO) and Bartlett.

To verify the trustworthiness and internal consistence of the variable group, the alpha test Cronbach was applied. This test was developed in 1951 by Lee Cronbach, and is a statistic tool fairly used among researchers to evaluate the internal consistency of an instrument. *Most investigators, with the possible exception of those who dedicate some attention to the psycometry area, tends not only to consider it an universally advisable index for the metric study of a scale (whatever the characteristics) but tend to perceive it as providing "credible estimative" of the "trustworthiness of a scale"* [17].

This application is necessary, for the respondents might have diversified opinions. Thus, with this test, it is possible to assess which variables must be eliminated of the instrument to increase its internal consistency, allowing its validation as a research instrument. The analysis if the internal consistency of the instrument is based in the *correlation of items in the same construction and the correlation of each item in the total score of this construction* [18]. Thus, it is desirable that items present some correlation between them, besides correlating to the total score of the construction.

The α index *estimates how uniformly the items contribute to the non-weighted sum of the instrument* [19] and vary in a scale of 0 to 1. Usually, an instrument is considered of satisfactory trustworthiness when the α value is equal or bigger than 0.7 [18]. The result of the test reveals that the test has internal consistency of 0.743 – a satisfactory value according to many authors [20-23]. The *alpha* value was obtained through the software *Statistical Packet for Social Sciences* (SPSS®).

As the questionnaire allows the use of factorial analysis in the data body obtained, we chose to apply additionally the tests Kaiser-Meyer-Olkin (KMO) and Bartlett, which *are two statistic procedures that allow inferring the quality of the correlations between the variables in order to proceed in the factorial analysis* [22].

KMO is a statistic test that varies between 0 and 1. A value lower than 0.5 indicates a weak correlation between the variables and, therefore, the factorial analysis is not seen as a good method in this case [22]. Barlett's test of sphericity is also related to the certification of correlation between variables. This test compares the matrix of correlation with an identity matrix (diagonal equals to 1 and all other measurements equal to 0). In case the hypothesis is confirmed (that is, the value for the significance in this test is higher than 0.05), the use of a factorial analysis is not appropriate to the data collected, for the lack of relation between the variables leads to weak factors or even their non-existence [24, 25].

Both tests (KMO and Barlett) were applied with the software SPSS® version 18. The results indicated a KMO of 0.796, which shows a good correlation between variables. This affirmation is corroborated by the significance indicator of 0.000 in the Barlett test, that is, consistent to the performance of factorial analysis.

Applicability of the questionnaire

After the validation of the questionnaire, such as presented in this paper, the instrument acquired the condition to be applied in large samples, being able to calculate percentage of agreement and disagreement of each affirmation and correlate different affirmations calculating the Pearson correlation coefficient (r). This coefficient measures the degree between two variables of the metric scale. The r coefficient can vary from -1 to 1. A value of r=1 means a perfect linear correlation

between the two variables; r=-1 is a perfect negative linear correlation, that is, when one increases and the other diminishes; and for r=0 there is no linear correlation between the variables. When r value is higher than 0.70 there is a strong correlation; r between 0.20 and 0.70 indicates a moderate correlation, and r between 0 and 0.20 shows a weak correlation.

The instrument developed has many positive aspects. Among them, the possibility of the researcher to have a quantitative analysis of each respondent or group of respondents, or even compare distinct respondent groups is singled out. Silva [26] and Silva *et al.* [27] applied this questionnaire in six groups of respondents: licensed in Biological Sciences, graduates in Biological Sciences and licensed in Linguistics and Literature – either Brazilian or Portuguese. In both papers, the questionnaire has proven to be an effective data collection instrument, for it allowed to extract the conceptions of science of the respondents (Axle 2) and understand how they understand the influences of ethical values in the scientific activity (Axle 1).

During the development of this paper, we found no instrument of data collection capable of relating both these axles and allowed to obtain the conceptions we aimed to analyze in the relevant literature. Therefore, we considered that the instrument created is an important contribution to future researches in the area of Science and Biology Education. The semantic and statistic validation ($\alpha = 0.743$) of the scale makes this a trustworthy data collection instrument which can be used in other researches, in order to provide de researcher more safety, since, theoretically, it lowers the risk, always present in open questionnaires, of very subjective questions that allow comprehensive or laconic answers.

At last, we stress that the quantitative analysis must be an additional way, and not the only way, for the researcher to find answers to their research problems. Such analysis can aid in lowering the subjectivity present in quantitative analysis. It is not a generalization of results obtained throughout the investigated universe, but a detailed comprehension of the conceptions of the subjects involved in the research.

References

1. Gil AC. Métodos e técnicas de pesquisa social. São Paulo: Atlas; 1999.
2. Babbie E. Métodos de pesquisas de Survey. Tradução de Guilherme Cezarino. Belo Horizonte: Editora UFMG; 2005.
3. Beere C. Development of a groups instrument to measure young children´s attitudes toward school.Psychol Sch.1973;10(3):308-15.
4. Hair JF, Tatham R, Anderson RE, Black W. Multivariate data analysis. 5ª ed. UpperSaddle River: Prentice Hall; 1998.
5. Lacey H. Valores e atividade científica. São Paulo: Discurso Editorial; 1998.
6. Lacey H. O princípio de precaução e a autonomia da ciência. Scientia e Studia. 2006;4(3):373-92.
7. Ferrer JJ, Álvarez JC. Para fundamentar a bioética: teorias e paradigmas teóricos na bioética contemporânea. São Paulo: Loyola; 2005.
8. Lacey H. Is Science value free? Values and scientific understanding. Londres: Routledge; 1999.
9. Lacey H. Existe uma distinção relevante entre valores cognitivos e sociais? Scientia e Studia. 2003;1(2):121-49.
10. Lacey H. Aspectos cognitivos e sociais das práticas científicas. Scientia e Studia. 2008;6(1):83-96.
11. Auler D, Delizoicov D. Alfabetização científico-tecnológica para quê? Ensaio. 2001,3(1):1-13.
12. García MIG, Cerezo JAL, López JLL. Ciencia, tecnología y sociedad:una introducción al estudio social de la ciencia y la tecnologia. Madrid: Tecnos; 1996.
13. Bazzo W, Linsingen IV, Pereira LTV. Introdução aos estudos CTS (Ciência, Tecnologia e Sociedade). Madrid: OEI; 2003.
14. Linsingen IV. Perspectiva educacional CTS: aspectos de um campo em consolidação na América Latina. Ciência & Ensino. 2007;1(número especial):1-19.
15. Fernandez BPM. Retomando a discussão sobre o papel dos valores nas ciências: a teoria econômica dominante é (pode ser) axiologicamente neutra? Episteme. 2006;11(23):151-76.
16. Lacey H. Ética e ciência: o dilema das pesquisas com células-tronco embrionárias [entrevista] 8 jan. 2008 [acesso 13 nov. 2011]. Disponível: http://www.ihu.unisinos.br/entrevistas/11536-etica-e-ciencia-o-dilema-das-pesquisas-com-celulas-tronco-embrionarias-entrevista-especial-com-hugh-lacey
17. Cunha AM. Ciência, tecnologia e sociedade na óptica docente: construção e validação e uma escala de atitudes [dissertação]. Campinas: Universidade Estadual de Campinas; 2008.
18. Kovaleski A, Pilatti LA. Ferramenta freeware para a realização do cálculo do Coeficiente Alpha de Cronbach. Ponta Grossa: Fundação Araucária; 2010.

19. Maroco J, Garcia-Marques T. Qual a fiabilidade do alfa de Cronbach? Questões antigas e soluções modernas? Laboratório de Psicologia. 2006;4(1):65-90.
20. Nunnally JC, Bernstein IH. Psychometrictheory. New York: McGraw-Hill; 1978.
21. DeVellis RF. Scale development: theory and applications. Newbury Park: Sage Publications; 1991.
22. Pestana MH, Gageiro JN. Análise de dados para ciências sociais: a complementaridade do SPSS. 2ª ed. Lisboa: Edições Silabo; 2000.
23. Malhotra NK. Pesquisa de marketing: uma orientação aplicada. 3ª ed. Porto Alegre: Bookman; 2001.
24. Mingoti SA. Análise de dados através de métodos de estatística multivariada: uma abordagem aplicada. Belo Horizonte: Editora UFMG; 2005.
25. Pereira JCR. Análise de dados qualitativos: estratégias metodológicas para as ciências da saúde, humanas e sociais.2ª ed. São Paulo: Editora da Universidade de São Paulo; 2001.
26. Silva PR. Análise das concepções de professores de biologia em formação inicial acerca da relação entre ciência e valores [dissertação]. Bauru: Universidade Estadual Paulista; 2012.
27. Silva PR, Araújo ESNN, Carvalho GS, Caldeira AMA. Concepções de futuros professores de biologia brasileiros e portugueses sobre valores éticos da ciência. In: Atas do 8º Encontro Nacional de Pesquisa em Educação em Ciências e do I Congresso Iberoamericano de InvestigaciónenEnseñanza de las Ciências; 5-9 dez 2011; Campinas, São Paulo. [Internet]. Campinas: Unicamp; 2012 [acesso dez. 2012]. p. 1-12. Disponível: http://repositorium.sdum.uminho.pt/bitstream/1822/20233/1/ENPEC_Etica_Br-Pt.pdf

Authors' participation

Paloma Rodrigues da Silva developed this research during her master's degree; Elaine S. N. Nabuco de Araújo was co-mentor; Ana Maria de Andrade Caldeira, the mentor and Graça S. Carvalho, research collaborator.

Received: 8.30.2012
Reviewed: 11.13.2012
Approved: 11.23.2012

Research article