

# **Construction and validation of the instruments to compare teachers' conceptions and school textbooks of 19 countries – The European Biohead-Citizen project.**

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*ABSTRACT: The FP6 European project Biohea-Citizen involves 19 countries and intends to compare syllabuses and textbooks as well as pre-service and in-service teachers' conceptions (systems of values as well as scientific knowledge). In this work we describe the collective construction process of the grids for textbook analysis, their validation and application in textbooks and we give exemplificative results obtained by the project consortium. Similarly, we present the methodology used for the questionnaire construction, including its translation into all countries languages and the methods for the translation validation as well as the pilot test used for analysing questions reliability and identifying the discriminating ones by using a MCA (Multiple Components Analysis), in order to produce the final questionnaire to be applied in all countries of the Biohead-Citizen project.*

*KEYWORDS: Textbook grids – Questionnaire construction – Multivariate analysis - Europe - Conceptions - Teachers*

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## 1. Theoretical background and framework of the Biohead-Citizen project

The European FP6 STREP project Biohead-Citizen ("Biology, health and environmental education for better citizenship" CIT2-CT-2004-506015) has started in October 2004 and lasts for three years. It aims to understand how Biology, Health and Environmental Education can promote a better citizenship, including their affective and social dimensions, by analysing possible differences in 19 countries and associating them to controlled parameters, (*e.g.* social context, religion, gender). It is expected that this understanding may clarify the relevant challenges that the European Education Systems have to face to maximise their efficiency in order to reinforce a knowledge based society. It includes 19 countries: 6 EU "old" member states (Portugal, France, Germany, Italy, England and Finland), 7 "new" member states (Cyprus, Estonia, Hungary, Lithuania, Malta, Poland and Romania) , and 6 INCO Countries (Lebanon, Tunisia, Algeria, Morocco, Mozambique and Senegal). This large East-West and North-South countries distribution was selected to enable a large transnational comparative study. All Participants have been associated to this project because they all have these both competencies: in a field related to biology, health or environment; and in human and social sciences, including the use of concepts and methods adapted (for science didactics research) from sociology, psycho-sociology and psychology.

We intended to develop a critical analysis of syllabuses and schoolbooks as well as to identify teachers' and future teachers conceptions (systems of values as well as scientific knowledge) in order to answer to the following questions:

- Are there reductive simplifications in teaching issues related to our selected topics on Biology, Health and Environmental Education, like "1 gene → 1 character"; "1 microbe → 1 disease" ? Do such teaching issues present or might they present notions of regulation, cycles, complexity? Are there implicit values, ideologies, in the curricula, syllabuses and school textbooks?
- What are the teachers' systems of values, including social and affective dimensions, about nature, body and health, sexuality, biologic determinism, evolution? Are their values interacting with their scientific knowledge? Are there differences among countries? Such differences, can they be associated to controlled parameters (gender, disciplines, religion, socio-economic context, recent history of the country, etc.)?

The theoretical background is the KVP Model (Clément 2004, 2006), where conceptions are analysed as interactions between scientific knowledge (K), systems of values (V) and social practices (P), and the goal is to carry out:

- A comparative analysis of syllabuses and school textbooks among the 19 countries. For each selected topic, one grid of analysis was constructed to be used by all participating countries in all school levels (Primary and Secondary Schools, i.e. from 6 to 18 years old students).
- A comparative analysis of the teachers' and future teachers conceptions (social representations) related to the project selected topics. The questionnaire was mainly

constructed by including questions from previously well tested questionnaires in the selected topics.

From a long list of topics to be worked out in the project, a list of six precise and concise topics were selected by the project consortium, corresponding to the emphatic questions where the interaction between the 3 poles of the KVP model are maximal: (1) Human brain: epigenesis, thinking, intelligence, spirit; brain diseases; brain at the command, or brain built by individual/social life? (2) Human Genetics: genetic determinism of human characters, genetic diseases, interactions between the genome and its environment (epigenesis), genetic engineering, GMO; (3) Human Origin: theories of evolution, with a special emphasis on the origins of humankind; (4) Human Reproduction and Sex Education: including related health questions and sexual transmitted diseases (AIDS, other STD, contraception, abortion); (5) Health Education: explicit and implicit values, nutrition, substance abuse (drugs), biomedical model and health promotion; (6) Ecology and Environmental Education (and Sustainable Development): explicit and implicit values, cycles, interactions, pollution, different philosophies on nature and environment.

In this work we describe the collective construction process of the grids for textbook analysis, their validation and application in textbooks and some exemplificative results by the project consortium. After that, we present the methodology used for the questionnaire construction, including its translation and the pilot test for analysing questions reliability and the discriminating ones by using a MCA (Multiple Component Analysis).

## **2. Construction, validation and application of grids for textbooks analysis**

The first year of the Biohead-Citizen project was dedicated to the construction of the grids for textbooks analysis and for the questionnaires preparation to be applied to teachers and future teachers. For this purpose, teams were asked to do some individual work on their own country data collection and subsequently meetings with the team leaders were organised in order to establish consensual decisions.

For the textbooks analysis, we constructed specific grids for each topic, using a didactical approach previously defined by P.Clément and his team, mainly to analyse the topic human genetics in French and Tunisian textbooks (e.g. Abrougui & Clément 1997). For each topic, we first defined the theoretical background, then our hypotheses and goals, and then the adapted instruments. We also assumed that the grids construction for textbook analysis should take up the contribution of all countries involved in the Biohead-Citizen project, in order to include the socio-cultural diversity present in the consortium.

The first stage was to ask each team to identify the presence of the 6 topics in their national education syllabuses (or programme/curriculum) from 5/6 years old up to 17-18 years old students and to prepare a “Syllabuses table”. This table included the textbooks concerned by each of the 6 topics: biology textbooks, but also more general science textbooks, or more specific textbooks as psychology for the brain, geography for environmental education, etc.

## 2.1. Grids construction

Being aware that some team leaders were more fluent in French (with difficulties with the English language) and others in English (with difficulties or unable to understand French), it was decided to carry out two separate meetings, one for more French-speaking teams (Algeria meeting) and another one for English-speaking teams (Malta meeting). This was found to be a good strategy of work as the workshops either in French or in English facilitated a high active and participative discussion. The two coordinators who speak both languages (Carvalho and Clément), attended both meetings in order to make a correct management of this task.

For the first meeting – hold in Algiers (6-10/05/05) – francophone participants took exemplars of their national textbooks concerning all topics in order to be used in the workshops for initial analysis and brief comparison among countries. Following deep discussions in each topic workshop one or two Biohead-Citizen members were designated responsible for concluding the first draft of each specific grid.

In this way the preliminary grids documents were organised and used in the subsequent Regional meeting in Malta (21-25/05/2005). More elaborated documents on the 6 topics were produced at this meeting and it was found out that cross grids, common to the six topics, should be done. The general structure of the grids is presented in Fig.1.

GRIDS FOR THE TOPIC (I) Reproduction & Sex Education	GRIDS FOR THE TOPIC (II) Human Genetics	GRIDS FOR THE TOPIC (III) Health Education	GRIDS FOR THE TOPIC (N → 6_)
<b>CROSS GRIDS</b>	<b>CROSS GRIDS</b>	<b>CROSS GRIDS</b>	<b>CROSS GRIDS</b>
C-1	C-1	C-1	C-1
C-2	C-2	C-2	C-2
C-3	C-3	C-3	C-3
C-4	C-4	C-4	C-4
C-5	C-5	C-5	C-5
C-6	C-6	C-6	C-6
C-7	C-7	C-7	C-7
C-8	C-8	C-8	C-8
C-9	C-9	C-9	C-9
<b>SPECIFIC GRIDS</b>	<b>SPECIFIC GRIDS</b>	<b>SPECIFIC GRIDS</b>	<b>SPECIFIC GRIDS</b>
(I) - 1	(II) - 1	(III) - 1	(N) - 1
(I) - 2	(II) - 2	(III) - 2	(N) - 2
(I) - 3	(II) - 3	(III) - 3	(N) - 3
(I) - 4	(II) - 4	(III) - 4	(N) - 4
(I) etc	(II) etc	(III) etc	(N) etc

**Figure 1.** Structure of the Biohead-Citizen grids constructed for the textbook analysis.

## **2.2. Grids validation and application**

Each team tested all grids (for each topic: the cross grids and the specific ones) on a single chapter for each topic. When possible, 2 persons of the same team tested independently the grids on the same topic chapter. If relevant differences between the researchers analysis were found, the grids should be rectified. Each participant sent to the coordinators its remarks – what was more interesting (the best results), what they had difficulty to apply and what was not applicable in their textbooks and why – in order to improve the grids.

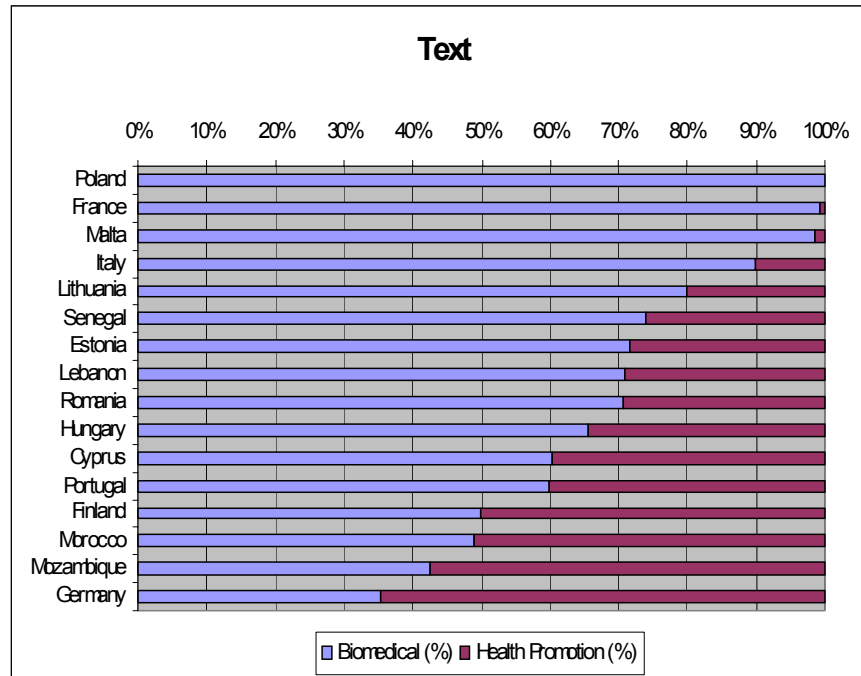
Taking into account all these remarks, the grids were improved for each topic, and the final grids were applied in each country. The results were centralised by us, and by a precise coordinator for each topic: Silvia Caravita for Ecology and Environmental Education, Graça Carvalho for Health Education, Pierre Clément for Human Brain, Sandie Bernard for Human Reproduction and Sex Education, Jérémy Castéra for Human Genetics and Marie Pierre Quessada for Evolution and Human Origins. The total number of textbooks analysed was 578, being 53 in “Human Brain”, 54 in “Human Genetics”, 42 in “Human Origin”, 64 in “Human Reproduction and Sex Education”, 83 in “Health Education” and 282 in “Ecology and Environmental Education”. In this last topic, 67 are in “Biodiversity”, 69 in “Ecosystems and cycles”, 80 in “Pollution” and 66 in “Use of resources”.

We organised an international Meeting of IOSTE (International Organisation for Science and Technology Education), Hammamet 7-10 February 2007, untitled *"Critical analysis of science school textbooks"*, where 38 countries were participating and presenting communications. This Meeting has been an occasion to present the first results of our Biohead-Citizen research on textbooks, including one collective paper for each of our 6 topics (Bernard et al 2007, Caravita et al 2007, Carvalho et al 2007, Castéra et al 2007, Clément et al 2007, Quesada et al 2007, Skujiene et al 2007). Figure 2 shows an example of 16 countries results, using one item of the grid “Health Education” where the biomedical model and the health promotion approach are compared. The biomedical model was characterised by the items pathologic, curative and preventive whereas the health promotion approach by the items healthy, empowerment and environment (Carvalho et al. 2007).

## **3. Construction, validation and application of questionnaires for teachers and future teachers**

### **3.1. Gathering previously tested questions for the Biohead-Citizen questionnaire**

Before the Biohead-Citizen project, the three coordinators had already worked in the areas of this project: Graça Carvalho mainly in “Health education” and “Human Reproduction and Sex Education”; Pierre Clément in “Human Brain”, “Human Genetics”, “Human Origin” and “Ecology and Environmental Education”; and Franz Bogner in “Ecology and Environmental Education”.



**Figure 2.** *Percentage of biomedical model and health promotion in the text of school books, in 16 countries.*  
*Numbers represent biomedical percentages.*

The first preliminary draft of the Biohead-Citizen questionnaire was constructed by the three coordinators still before the starting day of the project (01/10/2004). From our precedent questionnaires, the questions more relevant for the Biohead-Citizen project goals were put together and other questions from other research work were also added for the first draft. At the cooperative group meeting (in Portugal, 21-24/11/2004) some new questions were integrated, e.g. questions on Environment coming from Italy and Estonia.

At the Biohead-Citizen Kick off meeting, with all teams present (in Portugal, 15-19/01/2005) several questions were modified or discarded. After the questionnaire draft revision, the emerging first questionnaire was divided in 5 parts: T (Transversal, with 84 questions dealing with biology, health and environment), E (Environment: 38 questions), H (Health: 35 questions), B (Biology: 26 questions) and P (19 personal questions: gender, age, matter, academic qualification, religion, political position). Each question was discussed collectively to be sure that they had the same meaning throughout the 19 different countries of the project.

### **3.2. Translation of the questionnaire and translation validation**

To verify the quality of national-language questionnaire translations in relation to the original English, two specific methods were used: (a) two parallel independent

translations in the national language from the original English, then comparison by a third person (b) “back-translation”: the national version is translated back to English by an independent person and compared to the original English version.

In a first time, we wrote two questionnaires of reference: English and French. For the Arabic countries a more specific translation procedure was carried out. Both English and French versions of the questionnaire were used for a production of a Literary Arabic version. This questionnaire was then used (together with the French and/or English questionnaire) for the translation to the actual Arabic language used in each Arabic country. At the end there were three Questionnaires of reference: English, French and Literary Arabic one. All teams had access to these questionnaires to conclude definitively their questionnaires in their own language (English, French, Arabic, Estonian, Finnish, German, Greek, Hungarian, Italian, Lithuanian, Polish, Portuguese and Romanian).

This work on the translations has been fruitful for revealing the ambiguity of the formulation of some questions: in consequence they were changed and improved for the final questionnaire.

In addition, each team interviewed some teachers after they had filled the questionnaire, to identify the most problematic questions, and to suppress or to change them in the final questionnaire. The problems came sometimes from the translation, and sometimes from the questions themselves.

### ***3.3. A pilot test to analyse questions reliability and the most discriminating questions***

In 6 countries, the questionnaires were proposed twice to the same students, with more than one month between the two tests. To preserve the anonymity and to permit the comparison of answers of identified students, each of them chose a pseudonym and used it for the first test and the re-test. The questions with a low rate of reliability were then suppressed. Most of these were open questions. In consequence, the final questionnaire had not open questions.

The pilot test was applied to future teachers in 13 countries. The personal questions were filled in all countries but they are not used in the MCA (Multiple Components Analysis). They are only used in a second step to interpret the results of the MCA.

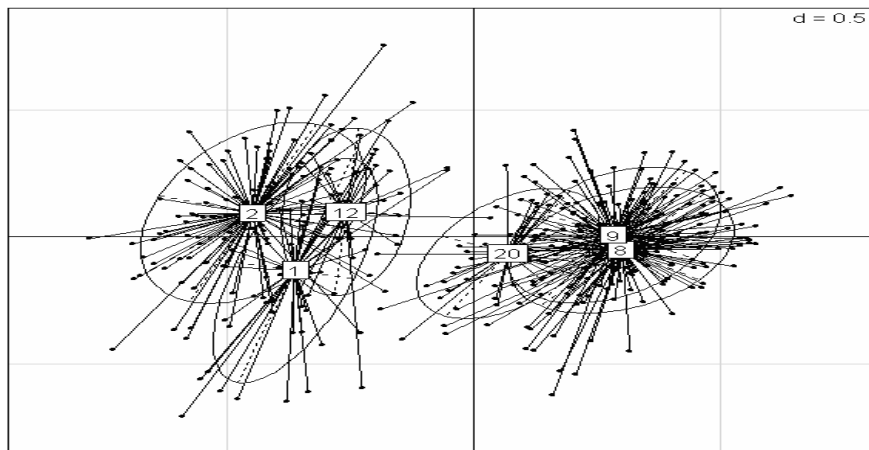
#### ***3.3.1. MCA applied to samples using all the questionnaires: 6 countries***

Only six countries applied the full pilot questionnaires, including the T, E, H, B parts. The total sample was 411 students (future teachers): Portugal (42), France (100), Hungary (24), Lebanon (113), Tunisia (108), Senegal (24). Figure 3 shows the results of the MCA applied to these six countries. Each point in this Figure represents one respondent; each ellipse is surrounding 2/3 of the respondents from the same country (identified by a number in the centre of the ellipse). The horizontal axis F1 is the most important one. Its meaning is given by the place, along it, of the modalities of answers to several questions (not drawn in Fig.3):

- Evolutionist answers are at F1 left side and creationist answers at F1 right side.

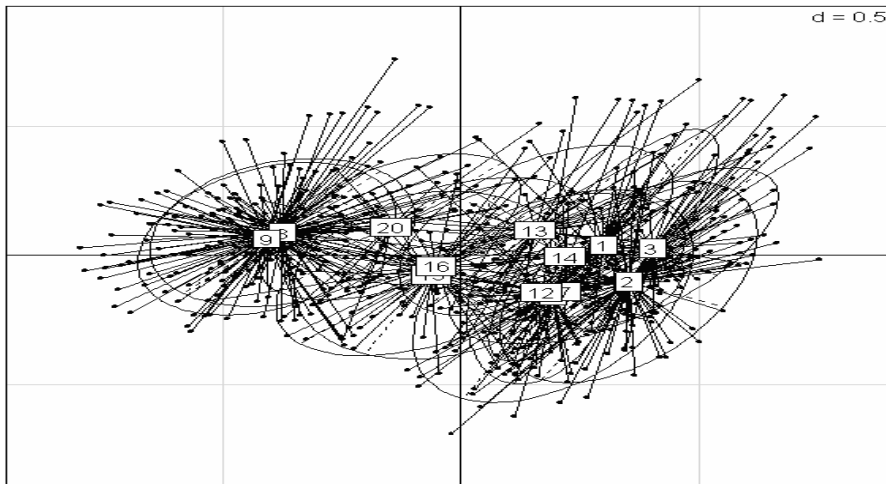
- Higher sexual freedom are at F1 left side, and their opposite at F1 right side.
- At F1 left side there is more reaction to protect the Environment than at right side.

The strong opposition in the conceptions of European and non-European pre-service teachers can be linked to some of the controlled personal variables, the most important of them being the belief in God (very important at right of the F1 axis; nearly all the atheist and agnostic are located at left). Muslims are mostly at right side and Christians are located all along the F1 axis.



**Figure 3.** Representations of MCA individuals, grouped by country (plane F1-F2).  
1:Portugal; 2:France; 8:Lebanon; 9:Tunisia; 12:Hungaria; 20:Senegal.

### 3.3.2. MCA applied to samples using T & E questionnaires: 13 countries



**Figure 4.** Representation of MCA individuals, grouped by country (axes F1-F2).  
1:Portugal; 2:France; 3:Germany; 5:Italy (under 12); 7:Estonia (under 12);  
8:Lebanon (under 9); 9:Tunisie; 12:Hungaria; 13:Lithuania; 14:Malta;  
15:Poland (under 16); 16:Romania; 20:Senegal.



The second MCA was applied to 13 countries that used only T (transversal) and E (environmental) questionnaires (and also the part P, with personal information that is not taken into account in the MCA). The total sample was 654 students: the same as in the precedent sample plus Germany (49), Italy (40), Estonia (21), Lithuania (44), Malta (17), Poland (32) and Romania (40) (Fig. 4).

The results of this MCA on 13 countries are similar to the precedent one (with just the inversion of the F1 axis: that was at left is here at right and reciprocally). The meaning of the axis F1 is the same. The new information is the position of some countries (Poland and Romania) in the middle between the European countries (at right) and the non European ones (at left).

#### ***3.4. Consequences for the construction of the final questionnaire***

The questionnaire used in the pilot test was too long (more than 80 minutes to fill it) therefore the final questionnaire had to be shortening to about half length. For this purpose most of the questions answered similarly by almost all responders in the pilot test were suppressed, assuming that this information is acquired and so no need to test it again. Also all the non reliable questions were suppressed

In contrast, the MCA discriminating and meaningful questions (in relation to our specific hypotheses) were maintained for the final questionnaire. The discriminating questions were identified not only by the MCA (Fig.3 & 4) but also by PCA and other statistical methods that are not exposed here).

Furthermore, the sampling procedure was well defined to be applied in all Biohead-Citizen involved countries: specific samples of in-service teachers and future teachers as well as the contexts and ways for the questionnaire application. Six samples were obligatory in each country, with at least 30 persons in each, and if possible more than 50: In-P = in-service primary school teachers; Pre-P = pre-service primary school teachers; In-B = in-service secondary teachers in Biology; Pre-P = pre-service secondary school teachers in Biology; In-L = in-service secondary teachers in Letters and Language; Pre-P = pre-service secondary school teachers in Letters and Language. The principal constraint for the questionnaire application was to be filled in with the presence of the researcher (to have 100 % of returns) and to guaranty the strict anonymity.

The answers to the new questionnaire were coded and included by each team in a specific Excel table, and then sent to the coordinators. All data were gathered and put together in the P2 team (France-Lyon) in order to carry out the statistical analysis between countries and inside each country.

#### ***3.5. First results from the final questionnaire***

Today, more than six thousands filled questionnaires were gathered from 16 countries. These data are in course of analysis. We used for that innovative multivariate analyses which were until now only used in ecology and not yet for questionnaires data. These methods are presented in another communication presented in this meeting (Munoz & Clément 2007). We also present in this AREF Congress, our first results on some topics involving several countries: Health

Education and Human Reproduction & Sex Education (Bernard et al 2007), Human Genetics (Castéra et al 2007), Evolution (Quessada et al 2007). We also present some first results limited to one country: Lebanon (Khalil et al 2007). The influence of the main variables (as gender, age, academic qualification, religion, religious practice and political position) are analysed and discussed for each specific topic.

#### 4. Acknowledgements:

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