SISSA – International School for Advanced Studies Journal of Science Communication
ISSN 1824 – 2049 http://jcom.sissa.it/

RECEIVED: October 21, 2008
PUBLISHED: April 30, 2009

Article

Opening the Test Tube: what do we know about research on science communication and the teaching of microbiology in Brazil?

Daniela Franco Carvalho Jacobucci and Giuliano Buzá Jacobucci

ABSTRACT: Brazilian research has grown intensely in all areas of microbiology, with the increase in the amount of governmental resources for the sector and the strengthening of a greater number of research groups. However, very few academic studies deal with research about teaching and science communication in microbiology. There is no in-depth study of how this topic is currently being divulgated in communication journals, didactic books and the Internet, or about the interest and the difficulties faced by researchers in communicating microbiology to the general public. This paper investigates academic production on science communication and the teaching of microbiology in Brazil and contextualizes the need for studies about the ways and means through which this activity is being carried out.

Introduction

The microbiology that resides in people's imaginary is related to diseases. This is due to Brazil's large television and print media, which give priority to communicating information about pathogenic microorganisms and lead the lay television viewer/reader to imagine that all fungi and bacteria are harmful to human beings. In addition to this form of prioritizing, it is not uncommon to encounter erroneous information about topics in microbiology being communicated by television programs, in widely-read weekly magazines and on the Internet.

Due to the demand for topics on public health, the majority of publications and actions of science communication in microbiology concentrate on diseases such as Acquired Immune Deficiency Syndrome (AIDS) and Severe Acute Respiratory Syndrome (SARS), thus causing society to support the allocation of public resources to research in this area.[1]

It is fundamental that citizens be aware of the fact that microorganisms do indeed cause diseases. However, the great majority of these organisms are dispersed in the environment without representing health risks. Rather, they contribute to the decomposition of organic matter and the recycling of nutrients, in addition to being used in the manufacturing processes of foods, pharmaceuticals and cosmetics; the recovery of areas contaminated by pollutants; the development of new materials; among other applications that improve people's daily lives.

In a publication of the *American Academy for Microbiology,*[2] several considerations are emphasized about the need to stimulate young researchers in the area of microbiology to educate the general public about microorganisms and to publicize information about how microorganisms, as key components to the entire biological system and the cycling of nutrients, determine life on Earth.

For researchers Freire and Gambale,[3] there is a lack of well-trained microbiologists for developing research and technology in Brazil. There is a need to reformulate undergraduate programs in Biological Sciences so that microbiology is highlighted in the curriculum and in order to attract professionals for scientific investigation in this field.

Getting the attention of youth who can become microbiologists and research professors in the area who are committed to avant-garde research is linked to formal teaching and the communication of topics in microbiology in the media and in non-formal educational settings.[4] But, what do we know about research on science communication[5] and the teaching of microbiology in Brazil?

This paper attempts to respond to this question and outline a panorama of the country's research on science communication and the teaching of microbiology.

Methodological outline of the research

In order to meet the research objectives and carry out a survey of information on research about science communication and the teaching of microbiology in the country, five sources of information were used:

- Continuous Database of the National Council for Scientific and Technological Development (CNPq) Directory of Research Groups in Brazil, through the website: http://dgp.cnpq.br/buscaoperacional/;
- Dissertation collection of the Coordination of Development for Higher Education Personnel (CAPES), through the website: http://www.capes.gov.br/servicos/bancoteses.html;
- SciELO Network – Scientific Electronic Library Online (www.scielo.br);
- Lattes Curriculum Vitae Platform of the National Council of Scientific and Technological Development (CNPq), through the website: http://lattes.cnpq.br;
- Annals of the XXIII and XXIV Brazilian Congress of Microbiology.

Such diversity is justified by the fact that this current study constitutes a case study[6,7] and the data from the stages of investigation make up a source and object of study.[8] Information from different origins is crossed in order to identify and analyze research on science communication and the teaching of microbiology in Brazil.

The research data is presented through two approaches: the first focuses on the panorama of research on science communication and the teaching of microbiology in Brazil; and the second deals with information about science communication in this area. A general discussion about the data focuses on the difficulties and challenges for the development of this field.

Panorama of Research in Science Communication and the Teaching of Microbiology in Brazil

There are currently 454 certified microbiology research groups in the Continuous Database of the National Council for Scientific and Technological Development (CNPq) Directory of Research Groups in Brazil, in sub-areas such as Microbial Ecology, Food Microbiology, Industrial Microbiology, Environmental Microbiology, Medical Microbiology, Biotechnology, Microbial Genetics, among others.

By using the keywords "Education/Teaching of Microbiology" in order to search for currently registered research groups in the CNPq Directory, 29 groups in this sub-area were found. However, none of them mention educational research on microbiology in their group name, thus making it impossible to immediately link research activities on education in microbiology to groups such as "Ecological Bee Raising of the Rural Federal University of Rio de Janeiro" or "Nucleus of Coastal Ecosystems of the Federal University of Sergipe". In these cases, only after carefully researching the production of the groups is it possible to associate some studies with education in microbiology.

The only research group to highlight science communication in microbiology in the topics "Science and Social Thought in Brazil" and "History of Ideas in Public Health" was the History of Sciences research group of the Oswaldo Cruz Foundation, led by researchers Lorelai Brilhante Kury and Nísia Trindade Lima.

By consulting the Dissertation Collection of the Coordination for Development of High Education Personnel (CAPES), it was possible to access dissertations and theses defended in Brazilian graduate programs since 1987 that contain "Education/Teaching of Microbiology" and "Scientific Communication in Microbiology" in the title and/or keywords or terms. The search resulted in 28 dissertations/theses on the topic. However, the majority of these works refer to basic and applied research in microbiology and not to teaching or science communication in this field. This is due to the fact that the system's search engine collects information in the words of the abstracts provided. An example of this is the dissertation of Reche.[9] This was the only result of the search on "science communication in microbiology". The dissertation deals specifically with the distribution and diversity of bacteria in flooded areas of rice fields in the state of Rio Grande do Sul. By having explained in the abstract that the study had already been presented in conferences, it was selected by the search engine for the topic requested.

Only three master's theses[10,11,12] and one doctoral dissertation[13] directly investigate questions regarding the teaching of microbiology, student conceptions about microorganisms and infectious diseases, the

teaching of microbiology to undergraduate students from the field of health and the dissemination of information about microorganisms via the Internet.

The SciELO Network has only one article on the topic "teaching of microbiology" in its collection of national scientific periodicals. This article is the work of researchers João Ruy Jardim Freire and Enilson Luiz Saccol de Sá[14] and was published in the magazine *Brazilian Journal of Microbiology*. It looks at the situation of microbiology in Brazil from 1990 to 2000 through a survey of bachelor's degree programs in microbiology and graduate degree programs in the area and discusses a plan for the development of microbiology in Brazil and the training of human resources.

Given the scarcity of articles on the target subjects of this study, we carried out an advanced search at CNPq's Lattes Platform, with the hopes of analyzing the curricula vitae of researchers that claim to work in the area of teaching of microbiology. We used the "Doctors and Other Researchers" (those holding master's and undergraduate degrees, students, technicians and others) database and searched by topic, using the "exact phrase" resource for the following terms: microbiology, science communication, education/teaching of microbiology, and science communication in microbiology. The curricula vitae that were found through the search, shown in figure 1, referred to the terms above in the title and in the keywords of the scientific and technological production of each researcher.

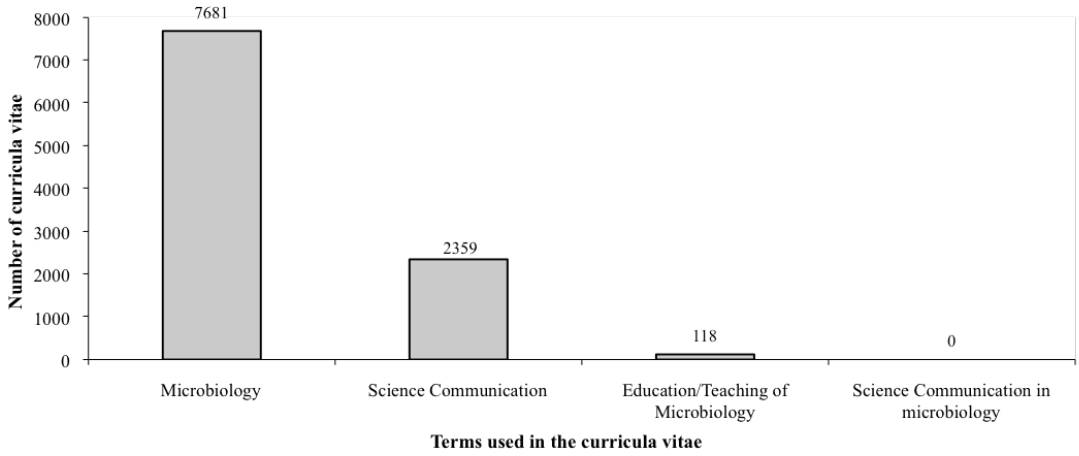

Figure 1. Number of curricula vitae of researchers who work in the area of microbiology that are registered at the CNPq Lattes Platform.

From the distribution of the curricula vitae in the topics analyzed, it is evident that the areas of "education/teaching of microbiology" and "science communication in microbiology" are little explored by researchers, in comparison to the expressive number of curricula vitae in the greater areas of "microbiology" and "science communication" in general.

Although there are records of 118 researchers working on the topic "education/teaching of microbiology," upon individually consulting each curriculum vitae in the Lattes Platform, it was possible to ascertain that only 39 of these researchers have academic production on this topic. The other 79 curricula vitae refer to the teaching of microbiology not as an area of research or a field of work, but rather as a didactic activity, mainly at the level of higher education. We looked at the works of these 39 researchers that were described in the Lattes curricula vitae and had been published in specialized journals and the annals of scientific events since 2000. In all, 69 works were found, including one book chapter,[15] 5 complete articles and 63 abstracts. The complete articles were published in the *Revista Brasileira de Educação Médica* (Brazilian Journal of Medical Education),[16] the *Brazilian Journal of Microbiology*,[17] the *Revista Cadernos Técnicos em Saúde* (Journal of Technical Notes on Health),[18] the *Revista Práxis* (Práxis Journal),[19] and the *Revista Microbiologia em Foco* (Microbiology in Focus Journal).[20] The abstracts were published mainly in annals of the following events: Brazilian Congress on Microbiology, Annual Scientific Meeting of the Butantan Institute, World Conference of Science

Centers, National Encounter of Research on Education in Science, and the Encounter of Biologists of the Regional Council of Biology-1.

With regard to the abstracts published in the Book of Abstracts of the XXIII Brazilian Congress on Microbiology, which took place in November, 2005,[21] and in the annals of the XXIV Brazilian Congress on Microbiology, which took place in October, 2007,[22] the number of studies and their topics in the area of teaching of microbiology are presented in figure 2.

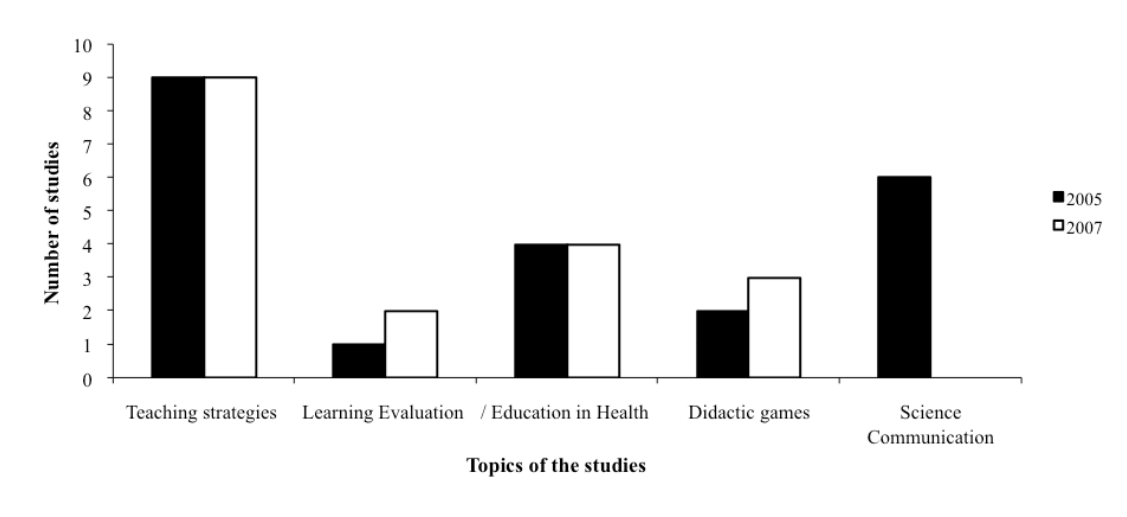

Figure 2. Studies presented in the area of teaching of microbiology in the two most recent editions of the Brazilian Congress on Microbiology.

The abstracts in the area of teaching of microbiology represent 1% of the total number of studies presented at each of the two most recent editions of the Brazilian Congress on Microbiology. Study topics show researcher concern for formal education about microbiology and society interaction through health education and science communication.

Having laid out this panorama of microbiology research groups and national production on the teaching of microbiology, we will now turn to some aspects of microbiology at the interfaces of education and the democratization of science.

Science Communication in Microbiology

In one of the rare studies on education in microbiology,[23] 6th grade students from different socio-economic backgrounds were investigated prior to biology classes for this grade as to concepts regarding microorganisms. It was not possible to establish a student standard of knowledge about microbiology in the thematic axes on health, biotechnology and ecology, given that the majority have concepts compatible with scientific content and some have incompatible concepts.

It is thus possible to infer that the correct concepts that individuals have about microorganisms can be obtained in two ways: through formal teaching as developed within the school setting; or by actions of science communication through the Internet, magazines, journals, television programs, visits to science centers and museums, and interactions with people who are knowledgeable on the topic.

With regard to formal learning, the use of didactic books at elementary and high school levels has become a determining practice for pedagogical action, given that these didactic resources, distributed free of charge by the Federal Government, often guide the school curriculum and provide some type of training for teachers.[24] Even though didactic books are used widely in Brazil, we did not find any thesis or dissertation that referred to the way in which they deal with microbiology.

In addition to the topic of microbiology being very little explored in didactic and supplemental books, updated information about the advances of microbiology are rarely divulgated in these books. This aids in creating an abyss between the knowledge generated at universities and that which is dealt with in schools. It is generally known that science and biology teachers who want to work with the topic resort to

communication journals and the Internet in order to obtain more precise information. Because of this, they end up facing information that is of dubious quality, which puts the veracity of the content to be dealt with in the classroom at risk.

Authors of didactic materials often use adaptations of science communication texts found in daily newspapers and communication journals in order to deal with recent information. However, the inclusion of such material does not further the articulation of scientific knowledge with the different possibilities of its applications and implications.[25]

Recent research[26] shows that the Google (www.google.com.br) search engine on the Internet is preferred by undergraduate students in order to look for technical information about microbiology. In this study, the author used the search word "microbiology" and analyzed the content of the first thirty pages that were found in the search. The author found that 26.70% of the links did not work, 23% did not have an informative title, 50% did not clearly state the authors, 70% had no type of bibliographical reference whatsoever, 80% made no mention of the page's updates, and 90% did not have a visitor counter. Lourenço et al.[27] state that, in addition to this, 46.6% of the pages found did not have content related to microbiology that could be considered sufficiently introductory and panoramic. The data presented by these researchers is worthy of a great deal of attention for three reasons: first of all, because the growth in use of the Internet as a learning tool and for bibliographical consultation by students is notorious; secondly, because little is known about the quality and credibility of the pages on microbiology found on the Google website; and thirdly, because the Internet is not only a consultation source on microbiology for students, but also for teachers and the general public who use this resource to remain updated and thus broaden their views of the world. Given this state of affairs, more in-depth research is urgently needed about how microbiology is being communicated on the Internet, on what pages and by whom.

Teachers have pointed out that reading texts about science communication – from communication journals and newspapers – is important in the sense of contributing to students' education by increasing their vocabulary and their knowledge. Working with these texts also enriches the class by allowing for the exchange of ideas between teacher and students and for discussion about social questions related to scientific knowledge.[28]

Although the use of science communication texts in the school setting is of great relevance, there are no academic studies about the quality of the information regarding microbiology that these communication journals provide.

The importance of education in microbiology refers to the social and public context of research in the area. People are generally cautious about microorganisms because they hear a great deal about the negative impacts that these organisms cause. They hear very little about the essential mechanisms of life support that such organisms perform.[29] Researcher Martha Marandino[30] states that scientific and technical processes and products fill our everyday lives and that, more than just discussing the real intentions of communicating science, it is fundamental that the public's appropriation of this knowledge be fostered as a means of social inclusion.

The only periodical specialized in the public perception of science, *Public Understanding of Science* (which has been published by SAGE Publications since 1992 and can be accessed at http://www.sagepub.co.uk) does not contain any articles about public opinion specifically in regard to microbiology. The journal is focused on reporting general topics of public understanding of science and has an electronic archive of approximately 720 articles. A search using the keywords "microorganisms" and "microbes" resulted in 14 studies that include topics related to the medical area and to biotechnology. This shows the scarcity of research about public opinion with regard to microbiology – not only in Brazil, but in all the world.

In the field of public understanding of science, there has been a change of focus in the scarce literature that is available towards a recognition of the different forms of knowledge that people have about science and the applications of this knowledge about science and technology in daily life.[31]

Education and strategic relations with the public are the foundations for constructing specialized knowledge that is capable of influencing decision-making in public policies about science, given that the public's familiarity with basic scientific concepts and principles has been proposed as essential for decision-making in a process of democratic administration.[32,33]

A study by the State of São Paulo Research Foundation[34] (FAPESP, 2004) on the public perception of science pointed out that recent studies in the area face the challenge of evaluating and interpreting the concepts of scientific culture. Thus, some indicators have been generally proposed; among them are the

attitudes of society in relation to scientific research, statistics about the number of visitors to science museums, studies about appearance in the media, and the frequency of reader access.

Despite being an indicator of great relevance for the evaluation of public perception about science, the visiting of science centers and museums in Brazil should be considered with caution. This is due to the following facts: there is a concentration of these science communication nuclei in the southeastern region of the country and visits are predominantly school visits and occasional visits, not to mention the scarcity of academic work on the nature and quality of the scientific exhibits found in these spaces.[35] As there is no national research about science communication in science centers and museums with regard to microbiology, it is not possible to establish a relationship between microbiology activities carried out at these locations, the visitation of the public, and public opinion about microbiology.

Difficulties and challenges

Even with the significant increase of Brazilian research in all fields of microbiology and the growing amount of public resources for this area, very few academic studies focus on the relationship between microbiology with teaching at all levels and society. This reflects a lack of stimulus for master's degree students, doctoral students and researchers to dedicate themselves to this study.

Despite being an important ramification of microbiology and having support from the Brazilian Society of Microbiology, the area of teaching of microbiology is still embryonic. There are very few activities, published works are rare, and there is no source of reliable information that can be easily accessed by the general public.

The Lattes Platform has been considered a reliable base of information about curricula vitae and is used by various funding agencies in order to consult researcher production. Therefore, it is hoped that those who place their curriculum vitae on the Platform keep their information updated in order to demonstrate their individual production and that of research groups, with the aim of financing their projects. This said, we believe that there truly is little national production on the topic of teaching and science communication regarding microbiology. It is not just a question of difficulty in gaining access to articles, dissertations and theses on this topic, given that the information stated in the curricula vitae shows that researchers really do not publish works of this nature in specialized periodicals. On the other hand, there are several studies found in the minutes of different scientific meetings that are published as abstracts. There is a need to discuss this situation.

Why do researchers not transform abstracts about the teaching of microbiology into articles for publication in specialized journals? There are some considerations that can be made. Studies that are published as abstracts are generally initial or partial research investigations. They often present reports of experiences about the teaching of microbiology in different educational contexts. In order to publish studies in the communication means that are available, researchers that wish to work in the area of the teaching of microbiology have two paths to follow – they can organize the text in English in order to submit it to periodicals which deal specifically with microbiology, such as the *Brazilian Journal of Microbiology*, or they can select a magazine from the field of education. Upon submitting work to a magazine that specializes in microbiology, researchers should be aware that their article may contribute greatly to the area and will get the attention of the greater scientific community that works with research on microbiology. Thus, only studies of great importance in the teaching of microbiology, such as the aforementioned article by Freire and Sá, can vie for space in periodicals that specialize in microbiology, given that the focus of these journals is the publication of basic and applied research in all fields of microbiology.

Upon choosing a magazine from the field of education in order to publish a study about the teaching of microbiology, researchers who specialize in microbiology face other difficulties. Qualitative research, commonly used in the field of education, differs in various aspects from the form of academic production used in the fields of biological and exact sciences. In order to structure a text about the teaching of microbiology in a format that is adequate for publication in a periodical from the area of education, researchers need to have basic knowledge with regard to the methodology of qualitative research and contextualize the study with a solid theoretical basis. Just as Deliziocov[36] believes that research on the teaching of science should be dealt with as applied human sciences, we can also extend this view to research about the teaching of microbiology. Thus, researchers need to touch on the area of microbiology with all its specificities and they need to organize the research through a socio-pedogical point of view. This requires experience in both fields.

Since few microbiologists specialize in education and vice-versa, research on the teaching of microbiology will most likely only be consolidated as a new area of study through the formation of multidisciplinary teams that join microbiology professionals with professionals from the fields of education, sociology, philosophy, and history, among others. This will thus allow for the development and publication of studies that are planned, structured and analyzed through a bipolar lens of microbiology/human and social sciences.

Final considerations

In order to increase the number of publications on the teaching of microbiology, there is a need to: disseminate the discussion forums on this topic beyond the space dedicated to them at the Brazilian Congress on Microbiology, which takes place every two years; stimulate the development of research projects by peers from different fields of knowledge; strengthen research groups in the teaching of microbiology that bring together researchers, undergraduate students and graduate students who are interested in researching their educational practices and actions of scientific popularization.

Because of the increase in research and research groups in the area of microbiology, the limited bibliographical production in the areas of teaching and science communication of microbiology, and the importance of establishing studies about scientific culture in Brazil, we understand that the carrying out of more in-depth research is urgently needed in order to determine the ways science communication on microbiology occurs in Brazil and in which types of media this appears. There is also a need to investigate the main difficulties that researchers face in order to work in the area of the teaching of microbiology.

This text has metaphorically sought to open the test tube and investigate what is being cultivated in the areas of teaching and of science communication of microbiology in Brazil. Now we must wait for growth.

Translated by Robert Gartner

Notes and references

[1] M. Schaechter, R. Kolter and M. Buckley, *Microbiology in the 21st Century: Where Are We and Where Are We Going?* Washington: American Academy for Microbiology (2004).
[2] http://www.asm.org/Academy/index.asp?bid=29245.
[3] J. R. J. Freire and W. Gambale, *A Situação do Ensino da Microbiologia no Brasil*, *Caderno de Farmácia* 13(1): 7-12, 1997.
[4] Spaces which differ from schools, such as museums, science centers, zoos, parks, aquariums, botanical gardens, among others.
[5] For more information about concepts and discussion on the topic "science communication", see:
a) W.C. Bueno, *Jornalismo científico no Brasil: compromissos de uma prática dependente*, Dissertation (Doctorate), Escola de Comunicação e Artes - Universidade de São Paulo, São Paulo (1985);
b) L. Massarani, *A Divulgação Científica no Rio de Janeiro: algumas reflexões sobre a década de 20*, Thesis (Master's), Instituto Brasileiro de Informação em Ciência e Tecnologia - Universidade Federal do Rio de Janeiro, Rio de Janeiro (1998);
c) J.M.M. Loureiro, Museu de ciência, Divulgação Científica e hegemonia, *Ciência da Informação* 32(1): 88-95, 2003.
[6] H.A.L.M. Lüdke and M. André,*Pesquisa em Educação: abordagens qualitativas*. São Paulo: EPU (1986).
[7] C. Laville and J. Dionne, *A Construção do Saber: manual de metodologia da pesquisa em ciências humanas*, Porto Alegre: Editora Artes Médicas Sul; Belo Horizonte: Editora UFMG (1999).
[8] A.J. Alves-Mazzotti and F. Gewandsznajder, *O Método nas Ciências Naturais e Sociais: pesquisa quantitativa e qualitativa*, São Paulo: Pioneira Thompson Learning (2002).
[9] M.H.L.R. Reche, *Distribuição e Diversidade de Bactérias em Áreas Inundadas de Arrozais do Rio Grande do Sul*, Thesis (Master's), Biology - Universidade do Vale do Rio dos Sinos, São Leopoldo (2003).
[10] A.M.O. Cunha, *Educação e Saúde: um estudo das explicações das crianças, adolescentes e adultos para as doenças infecciosas*. Thesis (Master's). School of Education - Universidade de São Paulo, São Paulo (1994).
[11] D.B.P. Dutra, *Avaliação da Disciplina de Microbiologia e sua Inserção na Saúde Coletiva*, Thesis (Master's), Collective Health - Universidade Luterana do Brasil, Porto Alegre (2003).
[12] A.F. Zômpero, *As concepções prévias de alunos sobre microorganismos*, Thesis (Master's), The Teaching of Sciences and Mathematical Education - Universidade Estadual de Londrina, Londrina (2004).
[13] F. Rossi, *Microbiologia Clínica e TelEducação no Brasil: um modelo de difusão de conhecimentos entre estudantes e especialistas*, Dissertation (Doctorate), School of Medicine - Universidade de São Paulo, São Paulo, 2002.
[14] J.R.J. Freire and E.L.S. Sá, *University Education and Training of Microbiologists in Brazil: 1990-2000*, *Brazilian Journal of Microbiology* 35: 1-10, 2004.

[15] J.M.G. Candeias, K.A.N. Hiroki and L.M.L Campos, *A utilização do jogo didático no Ensino de Microbiologia no ensino fundamental e médio*, in: S.Z. Pinho and J.R.C. Saglietti (eds.), *Núcleos de Ensino da UNESP*, São Paulo: Cultura Acadêmica 1: 595-603, 2007.
[16] L.M.H.F. Goulart, E.S. Erichsen, C.H. Piancastelli, C.M.P. Ribeiro and F.S.M. Noronha, *Aprendizagem Baseada em Problemas em Microbiologia no Curso de Medicina da UFMG*, *Revista Brasileira de Educação Médica* 25(3):22-27, 2001.
[17] J.R.J. Freire and E.L.S. Sá, *University Education and Training of Microbiologists in Brazil: 1990-2000*, *Brazilian Journal of Microbiology* 35: 1-10, 2004.
[18] V.S. Albuquerque and K.C. Felippe, *Uma experiência de aproximação do Ensino de Microbiologia e da proposta de projeto político-pedagógico em construção no Curso de Graduação em Enfermagem da FESO*, *Cadernos Técnicos em Saúde* 1: 37-46, 2006.
[19] G. Carreiro, D.D. Brito and R.M. Barbosa, *Ensino do uso racional dos antibióticos aos alunos do ensino médio*, *Práxis* 1: 23-27, 2006.
[20] A. Lourenço, S.D. Coutinho, V.M. Carvalho and R.C. Serafim, *O Oráculo de Delfos do Século XXI: a Microbiologia revelada pelo google*, *Microbiologia in foco* 1: 25-30, 2007.
[21] CBM. CD ROM do Programa e Resumos do XXIII Congresso Brasileiro de Microbiologia. São Paulo: Sociedade Brasileira de Microbiologia, 2005.
[22] CBM. CD ROM dos Anais do XXIV Congresso Brasileiro de Microbiologia. São Paulo: Sociedade Brasileira de Microbiologia, 2007.
[23] A.F. Zômpero, *As concepções prévias de alunos sobre microorganismos*, Thesis (Master's), The Teaching of Sciences and Mathematical Education - Universidade Estadual de Londrina, Londrina (2004).
[24] H. Fracalanza and J. Megid Neto (eds.), *O Livro Didático de Ciências no Brasil*, Campinas: Editora Komedi (2006).
[25] T. G. Nascimento, *O Discurso da Divulgação Científica no Livro Didático de Ciências: Características, Adaptações e Funções de um Texto sobre Clonagem*, *Revista da Associação Brasileira de Pesquisa em Educação em Ciências* 5(2): 15-28, 2005.
[26] A. Lourenço, V.M. Carvalho, S.D. Coutinho and R.C. Serafim, *O Oráculo de Delfos do Século XXI: a Microbiologia revelada pelo Google*, in XXIII Congresso Brasileiro de Microbiologia, 2005, Santos. Anais do XXIII Congresso Brasileiro de Microbiologia. São Paulo: Sociedade Brasileira de Microbiologia, 2005.
[27] A. Lourenço, S.D. Coutinho and V.M. Carvalho, *Ensino da Microbiologia: a Internet está substituindo os livros didáticos?*, in XXIII Congresso Brasileiro de Microbiologia, 2005, Santos. Anais do XXIII Congresso Brasileiro de Microbiologia. São Paulo: Sociedade Brasileira de Microbiologia, 2005.
[28] M.B. Rocha, *O Potencial Didático dos Textos de Divulgação Científica segundo Professores de Ciências*, Thesis (Master's), Educational Technology in the Health Sciences - Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2003.
[29] L. Sockett, *Microbiology – A Lifetime's Education*, *Microbiology Today* 28: 51, 2001.
[30] M. Marandino, *A pesquisa educacional e a produção de saberes nos museus de ciência*, História, Ciências, Saúde – Manguinhos, 12 (suplem.): 161-181, 2005.
[31] S. Cunningham-Burley, *Public knowledge and public trust*, Community Genetics 9(3): 204-210, 2006.
[32] C. Brunk, *Public knowledge, public trust: understanding the "knowledge deficit",* Community Genetics 9(3): 178-183, 2006.
[33] P. Sturgis, H. Cooper and C. Fife-Schaw, *Attitudes to biotechnology: estimating the opinions of a better-informed public*, *New Genetics and Society* 24(1): 31-56, 2005.
[34] FAPESP – Fundação de Amparo à Pesquisa do Estado de São Paulo. Indicadores de Ciência, Tecnologia e Inovação em São Paulo. São Paulo: FAPESP, 2004.
[35] D.F.C. Jacobucci, *A Formação Continuada de Professores em Centros e Museus de Ciências no Brasil*, Dissertation (Doctorate), School of Education - Universidade Estadual de Campinas, Campinas (2006).
[36] D. Delizoicov, *Pesquisa em Ensino de Ciências como Ciências Humanas Aplicadas*, *Caderno Brasileiro de Ensino de Física*, 21: 145-175, 2004.

Authors

Daniela Franco Carvalho Jacobucci – biologist, doctorate in Education, research professor at the Institute of Biology of the Federal University of Uberlândia, Brazil. E-mail: danielafcj@inbio.ufu.br.

Giuliano Buzá Jacobucci – biologist, master's degree and doctorate in Ecology, research professor at the Institute of Biology of the Federal University of Uberlândia, Brazil. E-mail: jacobucci@inbio.ufu.br.

HOW TO CITE: D. Franco Carvalho Jacobucci and G. Buzá Jacobucci, *Opening the Test Tube: what do we know about research on science communication and the teaching of microbiology in Brazil?*, *Jcom* **08**(02) (2009) A02.