Science popularization for preventing endemic diseases

A divulgação científica para prevenção de doenças endêmicas

Eline Deccache-Maia[1,2†], Gustavo M. Pires-Samtos[1], Ana Márcia Suarez Fontes[1], Tayane Fernandes[1,2], Ana Paula Castro Melo[1], Indira Trüeb[1,2], Aline do Carmo Vieira[1], Gabriel Ricardo Conceição Silva Gonçalves[1], Isabela Paixão[1], Itamara Albergaria[1] and Marcos A. Vannier-Santos[1,2*]

ABSTRACT

The "Science on the Road: education and citizenship" ('Ciência na Estrada: educação e cidadania', www.bahia.fiocruz.br/ciencianaestrada) project is an itinerant science education program bringing information on health and disease prevention as well as on general scientific topics. The project activities are mainly directed to low-income populations where parasitic and infectious diseases tend to be much more prevalent, due to inadequate sanitary and housing conditions. Most of the activities were held in Bahia state, but recently we are also taking part in events and studies in the Amazon region via the National Institute for Translational Research on Health and Environment in the Amazon Region, INCT-INPeTAm, CNPq/MCT. Our team counts on an itinerant laboratory built within a bus equipped with microscopes, cameras, computers etc. The intervention includes lectures, short courses and debates on parasitic and sexually-transmitted diseases, among other infections and hygiene habits. We employ posters, booklets, educative electronic games, videos, resin-made models of parasites, microbes and cells and incrustations displaying parasitic disease vectors. Theatrical performances and ludic activities are often used to enlighten the public about health and science. Eventually parasitological stool examinations, blood pressure measurement and blood group tests are performed not only as services for the population, but also to better understand the community health, enabling the planning of a more effective approach for our actions. The worst public health conditions were observed in the suburban periphery of the larger cities, whereas lack of scientific and health knowledge was mainly found in the rural areas. The students approached in communities revisited presented considerably enhanced health understanding and parents/teachers reported better hygienic habits. These observations reinforce the idea that health promotion and science education itinerant initiatives may improve public health, supporting social inclusion in poor regions.

Key-words: Health promotion. Science education. Parasitic diseases. Infections. Science popularization. Social inclusion.

RESUMO

O projeto "Ciência na Estrada: educação e cidadania" www.bahia.fiocruz.br/ciencianaestrada) é um programa itinerante de educação científica que difunde informações sobre saúde e prevenção de doenças, bem como sobre temas científicos gerais. As atividades do projeto são principalmente dirigidas à populações de baixa renda, onde as doenças infecciosas e parasitárias tendem a ser muito mais comuns, devido às condições sanitárias e de habitação inadequadas. A maioria das atividades vem sendo realizada na Bahia, mas, recentemente, também estamos participando de eventos e estudos na Região Amazônica através do INCT–INPeTAm, CNPq/MCT. Nossa equipe conta com um laboratório itinerante construído dentro de um ônibus equipado com microscópios, câmeras, computadores etc. A intervenção inclui palestras, minicursos e debates sobre doenças parasitárias e sexualmente transmissíveis, entre outras infecções e hábitos de higiene. São empregados cartazes, cartilhas, jogos eletrônicos educativos, vídeos, modelos em resina de parasitos, micróbios, células e incrustações exibindo vetores de doenças parasitárias. Performances teatrais e atividades lúdicas são freqüentemente usadas para esclarecer o público sobre saúde e ciência. Eventualmente exames parasitológicos de fezes, aferição de pressão arterial e testes de grupos sanguíneos são realizados não apenas como serviços para a população, mas também para melhor entender a saúde da comunidade, permitindo o planejamento de uma abordagem mais efetiva de nossas ações. As piores condições de saúde pública foram observadas na periferia e subúrbios das grandes cidades, que a falta de conhecimento científico e saúde foi encontrado principalmente nas áreas rurais. Os alunos abordados em comunidades revisitados apresentaram compreensão de saúde consideravelmente promovida e os pais e professores relataram melhores hábitos de higiene. Estas observações reforçam a idéia de que iniciativas de promoção da saúde e de educação científica itinerantes podem melhorar a saúde pública, apoiando a inclusão social em regiões pobres.

Palavras-chaves: Promoção da saúde. Educação científica. Doenças parasitárias. Infecções. Popularização da ciência. Inclusão social.

Dedicated to the memory of Prof. Dr. Henrique L. Lenzi, remarkable scientist, educator and outstanding human being!

"Não há nada mais terrível que a Ignorância em ação."

"There is nothing more frightful than ignorance in action."

(Johann W. von Goethe, 1749-1832)

"A pior doença do Brasil é a ignorância!"

Paulo Cesar Almeida

1. Laboratório de Biomorfologia Parasitária, Centro de Pesquisa Gonçalo Moniz, Fundação Oswaldo Cruz, Salvador, BA, Brazil. 2. Instituto Nacional para Pesquisa Translacional em Saúde e Ambiente na Região Amazônica, Conselho Nacional de Desenvolvimento Científico e Tecnológico/MCT, Brazil.

†Present address: Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro (IFRJ).

***Address to:** Marcos A. Vannier-Santos, Centro de Pesquisa Gonçalo Moniz/ FIOCRUZ. R. Waldemar Falcão, 121, Candeal, 40296-710 Salvador, BA, Brazil.
Phone: +55(71) 31762236
e-mail: vannier@bahia.fiocruz.br; marcos.vannier@pesquisador.cnpq.br

INTRODUCTION

Scientific literacy may be defined as the understanding of science, acquired through formal or informal education, required to cope with the rapidly advancing technology and the scientific knowledge influence on everyday life.

The informed decision-making process often requires scientific or technological knowledge. The deficient scientific literacy may leave large populations apart from technological advancements, therefore science popularization policies comprise a pivotal social inclusion strategy, particularly in developing countries[1].

According to the renamed Brazilian educator Anísio Teixeira "education is essential for democracy". Dr. Albert B. Sabin stated that "a scientist who is also a human being cannot rest while knowledge which might reduce suffering rests on the shelf." The present article describes a science and health initiative motivated by the principles presented above. Interestingly the former was a pedagogue and the latter, a scientist. This reminds us that science and education may

synergically walk hand-in-hand for a better society. Health and education are connected by reciprocal influence. Low educational level may lead to high infection or infestation frequencies, resulting in high child mortality because information deficient populations tend to be exposed to higher health threats[2,3]. On the other hand, different parasitic or infectious diseases may cause diminished cognitive development[4-9] and low adulthood productivity[10]. Thus health and education may be inextricably chained in a vicious cycle in which poverty generates disease, bringing reduced professional qualification and low salaries, leading to poverty and more infections. Interrupting this cruel cycle comprises a *sine qua non* condition to social development with justice and democracy. Therefore science diffusion in developing countries, particularly in low income areas, remains urgently required.

We believe that through education, particularly science education, the basic problems related to public health may be mitigated, since the population will have access to the knowledge required to prevent infections and demand improvements that promote quality of life and therefore augmenting social inclusion of a large population contingents living in poverty[11,12].

Science popularization initiatives reflect the Brazilian North-South inequality, just like the income distribution. According to the Brazilian Association of Science Centers and Museums, there are at least 190 Science Centers/Museums in Brazil, but no more than 6 are found in the North and 26 in the Northeast Brazil, whereas 112 are in the Southeast[13]. The South and Southeast regions present four-fold more science centers and museums than the other three regions altogether. In such a huge territory encompassing 26 states with dramatic social and economic discrepancies, marked by significantly unequal resources, it is amazing that no more than 20 itinerant science initiatives are known, none focusing health promotion. These should be particularly common in the North and Northeast regions.

The science popularization performed by the "Science on the Road" is aimed to help solving the problems reported here. The itinerance allows us to get to extremely low income areas, with little access to basic information, but the local population shows great interest in learning and we are so warmly welcome that most members of the group were even asked for autographs! It becomes clear at every moment, in every town or village that similar initiatives are required to reduce the remarkable social inequality in Brazil. Because of that our team is aiding the Brazil without Misery initiative.

"SCIENCE ON THE ROAD": A ROAD TO CITIZENSHIP

The project "Science on the Road: education and citizenship" is an itinerant science education initiative developed in order to promote health via education and science literacy, particularly among socially excluded populations in Brazil.

In a country like Brazil, with multiple social and economic scenarios, with one of the most unequal wealth distributions in the world, work of this nature is essential not only for health promotion but also for science popularization, leading ultimately to social inclusion. After five years, the FIOCRUZ team, composed by undergraduate, graduate students and researchers visited numerous poor communities both in the capital skirts and countryside towns in the state of Bahia.

The team uses a bus equipped with a laboratory and visits communities in different towns, where educational interventions are performed through lectures, short courses, workshops on health and science themes and activities using microscopes, well-illustrated colorful posters (using colloquial and jargon-devoid language), videos, resin-made models of pathogens and cells and incrustations in transparent resin displaying parasitic disease vectors such as *Biomphalaria glabrata* and triatomine insects as well as other invertebrates implicated in human infections. Houses makets were handcrafted in low cost or recycled material to illustrate the *Aedes* sp. reproduction domestic sites (**Fig. 1**). Particular parasites and vectors are emphasized in endemic regions. These activities promote the empowerment of the population that may become able to identify vector animals, avoiding risky contact and to inform their occurrence to the local health authorities.

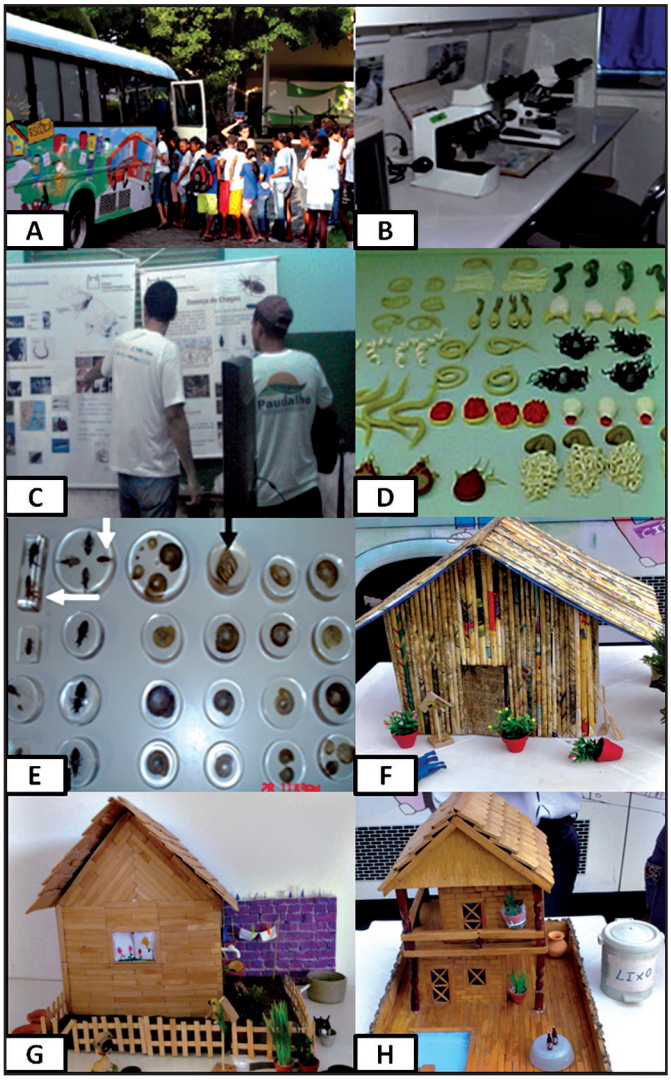

FIGURE 1 - A- Bus used in the Project "Science on the Road: education and citizenship". B-laboratory within the bus with microscopes, video monitor etc. C- Graduate student presenting basic facts about endemic diseases on posters. D- resin-made models of parasites and bacteria. E- Invertebrate vectors incrustated in transparent resin. Triatomine bugs are displayed besides non-hematophagous Hemiptera (white arrows) for comparison. *Biomphalaria glabrata* shells are displayed as well as a terrestrial gastropod (black arrow). F-H: House makets made with low cost or recycled material to present domestic and peridomestic breeding sites.

Microscopes are often used in both formal and informal education, but mostly in a low interactivity, but still fascinating manner. Our group generally employ light and electron microscopy to study parasites[14,15], but the acquired data seldom reach the general public. Thus the "Science on the Road" activities are intended to democratize knowledge.

We established an interactive, ludic activity, called "PhD" ("Per hour Doctor") with microscopes, simulating a parasitological diagnosis via stool examinations. At the end of the exams, students fill in a brief form with the diagnostic and receive a certificate, which is signed by the tutor and the FIOCRUZ researcher[16]. Therefore there is a double empowerment feeling. The school student is excited to receive a real certificate, which they keep carefully and the graduate students experience a sense of social responsibility. Thus, possibly the training of health professionals (some authoring this article) with conscience and commitment is one of the most relevant accomplishments of the "Science on the Road".

Videomicroscopy movies depicting parasites or bacteria fighting immune cells are presented in a dynamic and informal way (in a computer or via data-show – *vide infra*). Human neutrophils being destroyed by *Entamoeba histolytica* trophozoites are presented in order to demonstrate that although efficient, the immune response may fail, thus hygiene habits are required. This exhibition is usually performed before the visitors see the posters, microscopes etc, so as to incite curiosity and inquisitiveness about infection prevention.

String ("Cordel") literature publications, very popular in some regions in Brazil, were written to inform, in colloquial language, the most relevant aspects of Chagas disease, leishmaniasis and schistosomiasis (**Fig. 2**). The texts were prepared by two popular artists from Brazilian Northeast (Pádua de Queiroz and Pardal do Jaguaribe) and revised by our team, one physician and one pathologist before print. It is noteworthy that this kind of literature was popular in Europe, derived from the 'trovatore' poets, but became obsolete. Later this literature became very popular in Brazil and the books produced in this country are now commercialized in Portugal, where 'cordel' festivals now take place regularly. A booklet named "How to Avoid Parasitic Diseases" printed with illustrated material, devoid of medical or scientific jargon, is offered to parents, teachers and community health agents, with practical, simple and detailed explanations about disease prevention. Electronic educational games and animations are used in interactive way (**Fig. 2**). Games about dengue fever, were developed by Dr. Helena Castro at Universidade Federal Fluminense[17].

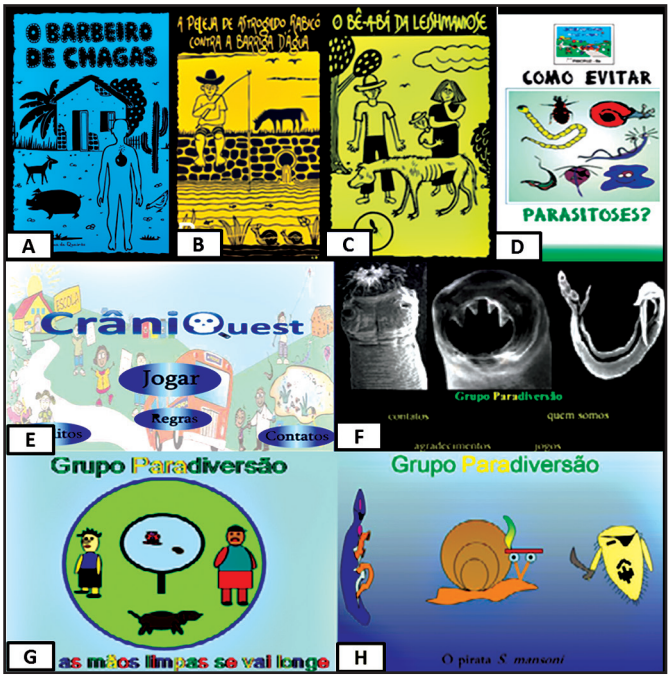

Figure 2 - String (cordel) literature books on Chagas disease (A), schistosomiasis (B) and leishmaniasis (C). D- The booklet "How to Avoid Parasitosis" was written in simple jargon-devoid language to present practical prophylactic procedures. E- A question-based electronic game was created to evaluate the health knowledge. F- Electronic stories presenting relevant basic aspects in the parasitic disease epidemiology. G and H- Electronic stories presenting relevant basic aspects in the parasitic disease epidemiology.

The principle of using low cost/recycled material was also applied to the creation of our giant cell. Based on the giant cells built at FIOCRUZ-RJ, we decided to create an itinerant one. The cell is mounted in an inflated igloo, 8 m in diameter, with the sayings "be inside the cell" or "the cell is *in*" at the entrance. The nucleus made up of plastic and cloth, with ribosomes and nuclear pores made of Styrofoam balls and beads, respectively. Inside the nucleus a computer projects via data-show the graphic computing images of cellular structures in operation and DNA molecules are presented both in plastic model and in another notebook, in an animated 3-D image. Endoplasmic reticulum and Golgi cisternae were made of cloth and foam, respectively. Mitochondria were made from PET bottles, containing metallic paper and color lamps. The activity is usually the cause of remarkable enthusiasm and excitement among kids (**Fig. 3**). Pure science activities are presented, including the 'Science Wizard', performed by a skillful, young and highly communicative graduate student, showing simple physics principles in a ludic interactive way. The aim is to present science in a pleasant way and to demonstrate that it may be done by a friendly "nearly" normal person.

As most of the hospitalizations in the world are due to water-borne infections, we also present the solar disinfection (SoDis) technique, using the solar UV radiation (**Fig. 3**) to eliminate diverse germs from drinking water[18,19]. This is a profound concern of the INCT-INPeTAm and "Science on the Road" teams.

Dirty hands may be the vehicle for diverse kinds of infection ranging from viruses, fungi and bacteria to protozoa and helminthes. Recently the H1N1 pandemics reminded us that the old-fashioned hand-washing procedure may be life-saving as they taught us at home/school. Unfortunately most people tend to forget what is not seen and, even washing hands, do it thoughtlessly and so that in a rather inefficient way. According to WHO (World Health Organization) "Handwashing with soap has been shown to reduce the incidence of diarrhoeal disease by over 40 per cent"[20]. Therefore we created an activity to demonstrate, unequivocally, the relevance of hand washing. Using digital hand microscopes, we allowed the population to evaluate the dirt in their hands (**Fig. 4**).

This simple and inexpensive activity demonstrates that not always the ultramodern equipment is required for scientific popularization and teaching. In the "Science on the Road" project we favor simple, low cost activities, for they may be reproduced in schools or homes.

A relevant part of our activity is related to the diagnosis of intestinal parasitoses by stool examination. The parasitic disease diagnosis is important not only for subsequent treatment, but also for rational planning of future interventions, optimizing prophylaxis. We previously established a partnership in which the Health Secretary

FIGURE 3 - Giant cell outside (A) and inside (B) view. Note organelles made of plastic, cloth and foam, as well as the data-show projection on the cell wall. C - Science Wizard performed in front of the giant cell. D - Exhibition of pathogen models. E – Explanation about prophylactic procedures in low income Amazonian community. F – Explanation about use the solar UV (SoDis) to disinfect Rio Madeira water for human use. After decantation to reduce turbidity and shaking for oxygenation, the traditional Amazonian riverside community exposes water in PET bottles to sun light for at least 6 h (inset) for effective UV-mediated microbicidal activity.

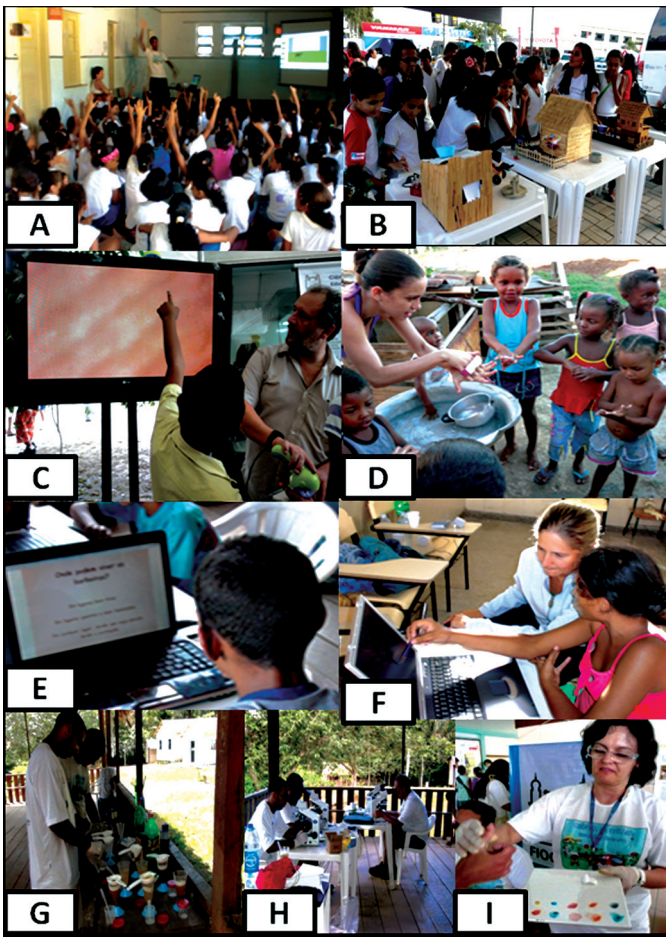

FIGURE 4 - Lectures on infections using electronic stories (A) and presentation with house makets and *Aedes* sp. Breeding sites – "dangerous neighborhood" (B). C- "Bionic eye" (Digital hand microscope) showing naked-eye invisible dirt on the hands of the students. D- After observing the dirty hand skin, the students are taught the proper hand washing technique. E- Students playing the CranioQuest game. F- Public School student explaining the videomicroscopy of immune response fighting parasites. G, H Parasitological diagnosis, by stool examination carried out in Amazon region. I – Blood type determination in a public school in Bahia.

furnished the drugs for chemotherapy. An educative intervention is needed not only for planning prophylaxis activities, but also for students to overtake the taboo about feces that many hamper such approaches, keeping the population under the risk of severe infections.

In some of the visited areas stool examinations were performed and the parasitic disease incidence was informed to the Municipal Health Secretary, so that treatments were granted and our team presented prophylactic measures to avoid reinfection/reinfestation. This was even done during an Amazon region expedition, integrating the INPeTAm INCT project, with real samples from the very population visited, using formaldehyde-fixed and numbered *i.e.* preserved anonymous and avoiding biological hazards samples (Fig. 4). In this expedition the INPeTAm team not only examined the presence of mercury in the traditional riverside population, including water, soil and the population *per se*, but popularized scientific information. The population awareness of the causes of both heavy metal and pathogen contamination is substantially empowering as they may be able to avoid the health threats, assuming a pivotal role in the democratic life of the region. Constant research evaluation will provide an overview of the effectiveness of our activities. We aimed to evaluate whether the language is appropriate and whether the material we produce is compelling. Questionnaires and a score-registering game were used to evaluate the knowledge accomplishments before and after science and health fairs in schools. Preliminary data indicate that the "Science on the Road: education and citizenship" activities significantly enhanced the students' knowledge about diseases and its prevention.

So far the project has accomplished considerable success in changing knowledge, attitude and practices toward health and hygiene.

SCIENCE MAKING FOR TEACHING

Since education is essential to the creation of a widespread science understanding, our project generally focuses the school as the central source of knowledge and citizenship in the community. Our activities were not restricted but frequently carried out in schools.

The education accomplishments in Brazil are comparatively rather limited. In the last decade Brazilians significantly enhanced reading habits as our average reading moved from 1.8 to 4.7 books per year, a remarkable improvement, but keeps the nation below the estimatives of developed countries and even some developing nations. Despite the increased book marketing, Brazil had a worsened reading comprehension score on the latest PISA exams of the

OECD[21]. Besides about 11% illiteracy (there are over 14 million illiterate Brazilians over 15 years old), the PNAD of the IBGE, showed that the country presents *circa* 20% functional illiteracy[22], but this concept is presently based solely on the studying years, rather than on reading comprehension or writing skills.

In the latest results of the PISA, Brazil had a small improvement in mathematics teaching, but continues with very poor results in science, appearing in the 53rd position among the 65 countries approached. The poor education in science, as well as in other disciplines, hampers the establishment of a general citizenship with opportunities for the poor. The vast majority of Brazilians, because of misunderstanding, is unable to properly opine on issues like stem cells from adults or embryos, transgenic food, human cloning, global warming, biodiversity, sustainable development or even whether the experiments cyclotron could generate a black hole and destroy our planet.

The eminent researcher Carlos Chagas Filho, son of the Chagas' disease discoverer, stated that "we teach at the university because we research".

Furthermore young students tend to enthusiastically share the knowledge acquired, therefore becoming natural science multipliers. We observed that on several occasions in which enthusiastic students joined our team and helped on the activities. Juliana L. gladly explained the videos to the public, including FIOCRUZ researchers (**Fig. 4**). Little Dom was even nicknamed "little teacher" by the colleagues. Because of such remarkable demonstrations of students unequivocal excitement and aptitude to act as knowledge multipliers, we created a two day-long (4h/day) course on parasitic and infectious diseases (**Fig. 5**), where the students were trained to act as health information disseminators, not only within their homes, but also at school and neighborhoods. They were so contented to take part in the activity that immediately we were notified of a long list of students eagerly waiting for an opportunity to join the group. We were glad to hear from a school director that some misadjusted kids improved their behavior significantly, towards colleagues and teachers.

Science education and popularization may not only promote critical thinking, but also stimulate scientific vocations among young people[23].

The prominent biochemist and educator Prof. Dr. Leopoldo de Meis long pursues these ideas viewing the scientists playing the fundamental role of translating science to the public, therefore he created at UFRJ a Science Education Network, that now exists in over 20 universities or Research Centers in Brazil[24].

Because of our actions divulging science particularly focusing parasitic diseases[25-27] to the general public, we were invited by Dr. de Meis to join the Science Education Network, now known as New Talents of Public Schools. The network is devoted to propagate the use of the scientific method and experimental reasoning in the classroom, enhancing understanding and therefore empathy about the scientific knowledge.

The information transmission to young people, not only promotes infection prophylaxis, but also stimulates interest in science. The activity of our team in courses for school science teachers resulted in valuable partnerships, including the Education and Health Secretaries. In this project four science teachers from different public schools received scholarships as well as 7 school students and 4 graduation students, for assisting the project activities, creating innovative experimental activities in classroom and to revitalize the school laboratories (**Fig. 5**).

FIGURE 5 - A – short course for public school students, approaching fundamental aspects of parasitic and infectious diseases. B and C- Students explaining the theme to school mates, and even to their teachers (D), during science/health fairs. Courses offered to public school science teachers (E, F) focusing low cost experimentation, employing the scientific method.

CONCLUSION

In the last four years the "Science on the Road" project reached more than 70,000 people, mostly young students. There were several institutions visited by the project including schools, health centers, public squares, churches, spiritual centers, yards, in many municipalities. The testimonies declared both orally and written or through drawings, showed us how much information work in this area is important. The science popularization has been focused and stimulated in public national policy, as presented in the introduction of this text. However, there are scarce initiatives of this nature away from the Rio-São Paulo-Belo Horizonte axis. When the focus is shifted to the Bahia countryside, this discrepancy is even more impressive. It is not surprising that our arrival in the cities visited our project becomes an important event, mobilizing the entire population, demonstrating that the learning desire is not confined to big cities, as opposed to opportunities. It recalls the event when Oswaldo Cruz was asked wether only "great nations" should make science, he answered that making science makes these nations great. Visiting the city of Iguaí a student wrote that "the coming of 'Science on the Road' at our town was a real revolution." We know we cannot promote a "revolution" *per se*, but the thought of this kid lead us to the insight of the little revolutions that science can engender.

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