



ICTE 2016, December 2016, Riga, Latvia

Information Technology and Public Health: Possibilities for Innovation through Interdisciplinary Actions

Jose Tarcisio Franco de Camargo^{a,*}, Eliana Anunciato Franco de Camargo^a, Estefano Vizconde Veraszto^b, Gilmar Barreto^c, Patricia Aparecida Zibordi Aceti^a, Ademir Salvi Junior^a

^aCentro Regional Universitario de E. S. do Pinhal (UNIPINHAL), Av. Helio V. Leite, s/n, E. S. do Pinhal, SP, 13.890-000, Brazil

^bUniversidade Federal de Sao Carlos (UFSCar), Rodovia Anhanguera, km 174, Araras, SP, 13.604-900, Brazil

^cUniversidade Estadual de Campinas (UNICAMP), Av. Albert Einstein, 400, Campinas, SP, 13.083-852, Brazil

Abstract

The new technologies of information and communication permeate our daily lives in various contexts. This reality allows us to reflect on the use of technology as a mechanism for the development of innovative solutions to various problems affecting society. In this sense, this work presents some tools that contribute to the solution of a serious public health problem, common in tropical countries: the monitoring of breeding sites of the *Aedes aegypti* mosquito larvae, vector of diseases such as dengue, Zika virus, yellow fever and Chikungunya fever. In its larval stage, this mosquito uses containers with stagnant water as breeding sites. The localization and elimination of breeding sites, together with the guidance to the population, is an effective way to combat mosquitoes and reduce the number of cases of infected individuals. To do so, it was developed and made available to the population in general, a set of technological tools, based on “apps” for smartphones, through which anyone can indicate breeding sites of mosquito larvae. In addition to an app for the geographic markup of breeding sites, there is also another app and a website that allows everyone to view the marked sites, making it possible to build a geographic representation for the distribution of *Aedes* larvae breeding sites. In a pilot test, it was possible to verify that the use of new technologies in controlling and monitoring of insects that are considered vectors of diseases is significantly efficient. It was generated a considerable volume of information that enables the development of control strategies and actions to combat the vector in question by the competent authorities. Also, this pilot test involved a large number of persons: undergraduate students and teachers from information technology and health areas, public professionals that are responsible for epidemiological monitoring and the population in general. Indirectly, the implementation of these technological tools promoted the interdisciplinary integration among teachers and students in the areas of information technology and public health in a Brazilian university. Similarly, the project also integrated university, population

* Corresponding author. Tel.: +55-19-3651-9630 ; fax.: +55-19-3651-9600.
E-mail address: jtfc@bol.com.br

and the government around the purpose of controlling the advancement of diseases that have caused severe negative impacts on society. It was concluded that the rational use of new technologies, pointing towards solving problems that affect society, is able to provide innovative solutions, promoting the construction of interdisciplinary actions in education, integrating different areas of knowledge and these with competent agencies and society in general.

© 2017 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of organizing committee of the scientific committee of the international conference; ICTE 2016

Keywords: System design; Environmental monitoring; Interdisciplinary research

1. Introduction

Dengue, Chikungunya and yellow fevers as well as Zika virus are public health issues which, given their current relevance, transcend disciplinary knowledge in the area of health and need the support and coordination of other areas of knowledge to be effectively dealt with. Thus the new technologies of information and communication (NTICs) appear as instruments through which interdisciplinary actions can contribute to solving part of the problem in question.

Specifically, the resources made available by the NTICs emerge as proper tools to handle this theme under the points of view of monitoring and democratization of access to information and consequent social awareness about the severity of the problem. After becoming aware of the presence of these diseases and getting handle of more information on them, the population starts to serve as an active agent in fighting these illnesses. This way, nearing NTICs to other areas of knowledge, building an environment conducive to producing interdisciplinary actions, can be a suitable approach to provide to a significant portion of the population the ability to build effective decisions for public health¹.

From this reflection and the premise that fighting *Aedes aegypti*, the vector of the diseases previously mentioned, is a collective obligation, it is necessary to determine, considering scientific and technological knowledge available, which monitoring and control activities are likely to be achieved².

Methodologies using the so-called “guidance by social objectives” can be effective in demonstrating the reality of a problem in analysis and the possibilities of human intervention, based on either social, economic or cultural aspects. Specifically concerning the diseases transmitted by the *Aedes Aegypti*, it is vital that governments, educational institutions and the community recognize the social gravity related to transmission of these diseases and the increasing possibilities of aggravation. All segments of society must question themselves on how long this vector can be responsible for so many people getting sick and often weakened for a lifetime.

In this sense, this paper presents an interventional action held together by ordinary citizens, health authorities and the academic community in order to democratize access to information about mosquito breeding sites and, helping the competent public entity in the awareness of the population and in the eradication of the detected breeding sites.

2. Theoretical background

The diseases transmitted by *Aedes aegypti* has stood out as some of the most worrying illnesses in the world³. In Brazil, where this work was performed, a process of intense viral circulation began in the 1980's, with epidemics that reached all regions of the country. Today, Dengue, Chikungunya and yellow fevers as well as Zika virus are the main pathologies associated with the mosquito.

The proliferation of this vector predominantly occurs by the deposition of eggs and the consequent creation of larvae in stagnant and relatively clean water, making the urban environment highly favorable to the proliferation of *Aedes*⁴. In this scenario, the role of vector control in public health is to prevent infection by blocking or reducing the transmission, being its main objectives⁵:

- Handle existing problems such as outbreaks, epidemics, high mortality and high morbidity
- Prevent epidemics or the reintroduction of diseases
- Reduce the environmental risk factors of transmission

This study focused on the goal identified as third, once the reduction of environmental risk factors can be achieved by monitoring and eradication of outbreaks of *Aedes Aegypti*. In this sense, providing tools so that the general public can identify and register mosquito breeding spots, in addition to alert the competent health authorities, can contribute significantly to the reduction in the number of breeding and subsequent decrease in the number of humans with the disease.

This type of premise has achieved significant prominence today, especially in developing countries, through the concept of "mobile health" or "m-health", i.e. the use of mobile technologies such as cellular phones to support public health and clinical care⁶. Mobile technologies are widely available, even in under development countries, and can play an important role in health care at the regional, community, and individual levels⁷.

Through mobile technologies currently available, it is possible to accurately identify breeding sites of *Aedes Aegypti*. Georeferencing tools such as GPS or A-GPS, present in most smartphones being sold today, as well as the embedded software in these devices, allow not only the identification of geographic coordinates (latitude and longitude), but also the device's postal addresses. In addition to recording points of interest, mobile devices are also capable of transmitting such information in real time, building in a central hub, a database with information that is fully accessible through web browsers, such as those available in personal computers or even smartphones.

The efficient use of mobile technologies in public health, however, depends on the construction of properly planned actions. It is not, therefore, only about the simple application of a disciplinary content (mobile technology) in another area of knowledge (public health). Beyond that, this is a problem of construction of new interdisciplinary knowledge. In fact, the simplified view of the application of knowledge from one area into another, also called "multidisciplinarity", culminated in an excessive disciplinary specialization which prevailed until more than half of the 20th century, eventually difficulting the solution of issues among different areas of knowledge, precisely due to the lack of dialogue among knowledges⁸.

Thus, multidisciplinarity is characterized when the solution to a problem only requires the use of specific knowledge of one or more sciences. This approach does not lead to the enrichment or construction of new knowledge among the disciplines that are used for the solution of a given problem. In this scenario there is only the transfer of knowledge from different areas for the construction of a whole. Interdisciplinarity, in its turn, implies the exchange and integration of sciences, resulting in the mutual enrichment and the creation of new knowledge, which we started to call "innovation"⁹.

Under this perspective, the work presented here began from theoretical reflections involving teachers from the undergraduate courses of Computer Engineering, Nursing and Pharmacy from a Brazilian University. Such reflections led to the practical implementation of a monitoring and control mechanism of the *Aedes Aegypti*, tested in an urban region inhabited by approximately 50,000 people. Thus, it was possible to recognize that the practice requires theoretical reflection, which means that interdisciplinarity is much more than the compatibility of methods and techniques, it is, in fact, a necessity for the solution of problems related to the historical and cultural reality in which the human population is inserted¹⁰.

3. Methodology

From the premise that the fight against *Aedes Aegypti* is a collective obligation, the collegiate of undergraduate courses in Pharmacy, Nursing and Computer Engineering from the Centro Regional Universitario de Espirito Santo de Pinhal (UNIPINHAL) developed interdisciplinary activities in order to build a georeferencing software, providing data that can be arranged in the form of a map, which allows its use in tracing breeding sites of mosquito larvae. The information made available by the system served to assist the work of technicians responsible in the control of diseases, especially regarding decisions about actions to be developed along the populations^{11,12}.

Thus it was opted for the development of a prototype in two related fronts:

- Implementation of applications for mobile devices and a website for marking, control and visualization of potential breeding grounds of *Aedes Aegypti*
- Mobilization of the academic community, in order to disseminate the tools built and prepare the local population for their proper use, showing the potential benefits that the use of these tools can bring

In this scope, the prototype presented made feasible the use of this tool by any person, democratizing access to information and speeding up the implementation of actions by the Government.

4. Results and Discussion

The technological core of the project is based on two applications for mobile devices, a website and a database that stores the geographical coordinates and other relevant information about places that may have breeding sites of *Aedes Aegypti*. Through the “apps”, users can mark suspicious places that may contain mosquito larvae, and see the location of points marked by other users. The website provides an alternative mechanism for consultation to suspicious locations, being accessible to any Internet-connected device. The database, in turn, stores the records sent by users of the apps, making them, at next, accessible to the public in general.

The mobile application that records sites that may contain mosquito larvae is called “*Aedes* Map Marker” (see Fig. 1a). This app is the main technological feature of the project, aiming to allow any person to record the location of a possible breeding site. Since this is an application which may be used by a large number of users, regardless of their educational level, its interface is very simple, making its use quite intuitive. To mark and send a specific location, just approach the site and click on the button “Send Location” of the interface. Optionally, before sending his location, the user can record any relevant information in the “Observation” field. When a place is marked, the following information are sent to the project database: the geographical coordinates (latitude and longitude) of the place, the date when the site was registered, the IP address of the device that made the record and the note that may be performed by the user.

The application for mobile devices that displays the set of locations marked by all the participants of the project is called “*Aedes* Map Viewer” (see Fig. 1b, 1c). This app allows users to observe, initially, the set of all points marked on the map. This initial view allows an user to become aware about the scale of the problem faced, simultaneously observing the dispersion and the density of the points marked. It is also possible that the user focus his attention on a particular region of the map, using the “zoom in” and “zoom out” tool provided by the map. In addition, the user can experience a third level of immersion, consulting specific details of a marked point (just “touch” on the spot, to do so).

The project website consists in a redundancy for displaying the marked points, allowing the set of registered locations to be displayed not only by means of a mobile device but, also, from other computers (or graphical devices) that have access to the Internet (see Fig. 2).

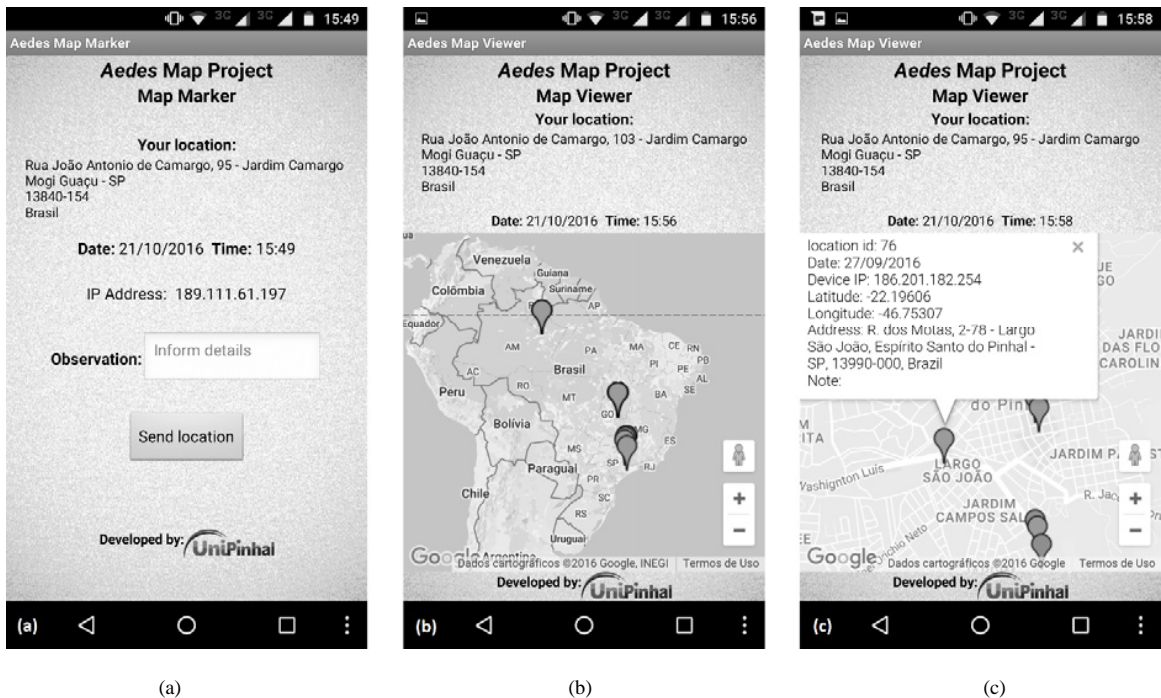


Fig. 1. Apps for the “Aedes Map Project”: (a) Marker and (b, c) Viewer.

All facilities present in the “Map Viewer” app are also on the website. Thus, through the website, initially the user will have access to the general distribution of points, and then may come to focus his attention on a specific region and, also, consult details about each place marked. An advantage of the website is the fact that, through this, it is possible to see additional information about the structure and the work proposed by the project. This website is accessible from the address <http://engenharia.unipinhal.edu.br/mapadaoedes>.

The “non graphical” element of the project is the database, which stores the points marked by the users, making them immediately accessible through the website and the viewer app. Through the database it is possible to build queries and generate statistical reports for the registered points. For example, it is possible to determine how many points were marked in a particular region or in a given period. Such information enables the construction of reports pointing out the gravity of the situation in a particular region or time interval.

The activities built with the developed work, when observed under a reductive point of view, could be classified, mistakenly, as multidisciplinary, which does not correspond to the reality of what was done. In fact, at first, someone might imagine that the activities based on technology would concern exclusively to professionals in the technological area and, in turn, the actions for dissemination and awareness of the population would be responsibility of health professionals. This does not correspond to the reality of this project.

In fact, the construction of the technological tools heavily depended on the participation of health professionals, since these professionals, teachers and students of Pharmacy and Nursing courses, dominate the problems involved in monitoring and control of the vector of the diseases in question. In turn, Engineering course professionals were responsible for making the tools “friendly”, initially accessible to health professionals, so that, then, this technology would be delivered to the society.

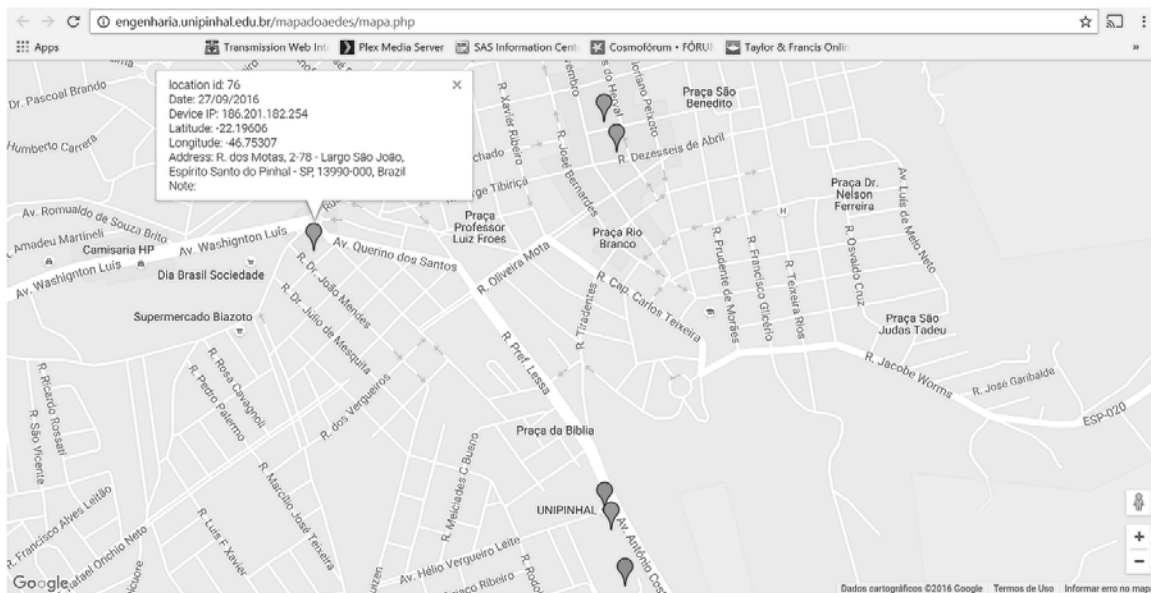


Fig. 2. “Aedes Map Project” website.

In addition to the proper implementation of technological resources, the preparation of human resources for its use also showed interesting results. There was wide acceptance of the project by the academic community where this project was developed, and the students end up becoming multipliers of the idea along the general population.

Far beyond the technology implemented in order to partially solve a public health problem, this work showed that, through collective effort, it is possible to design and implement interdisciplinary activities that have a real social impact. To do so, the coordination and the planning carried out by the academic community were essential, in addition to the actions developed jointly by teachers and students of the university.

It is noteworthy that the transmission cycle of the diseases involved with *Aedes Aegypti* is complex, involving some environmental and climatic conditions which may determine the geographical distribution of cases. Thus, the identification of mosquitoes breeding places assists the government in the destruction of these breeding sites and in the guidance of the population, facilitating the planning for control strategies, reducing financial costs and improving the understanding of the affected populations regarding the epidemiological dynamics of the diseases. In this way, the technological tools made available to the population contributed significantly to the monitoring and control of *Aedes Aegypti*. In fact, the use of these technologies has promoted an important strengthening of relations among population, university and local government.

5. Conclusion

The analysis of the data generated by georeferencing systems, such as the one built from this proposal, serves as a support mechanism for the "information-decision-action" triad. Thus, building interdisciplinary actions is a challenge through which it is necessary to overthrow outdated paradigms that are still rooted in the global work structure. This is, however, an action that crucially depends on the articulation of the actors involved in the knowledge construction process.

It is not enough to promote interdisciplinarity only in its conceptual and academic level. It is necessary to practice it in the social scope, extrapolating the university gates. Despite the existence of countless difficulties for the

development of interdisciplinary projects in under development and/or emerging countries, this research demonstrates that the barriers are not insurmountable.

In general, what is observed in this scenario (and must be changed) are professionals who expect the formulation of methodological practices that are “ready to use”, which can simply be applied in specific contexts. In this sense, it is a priority to emphasize that the space reserved for the collective construction of new knowledge must promote the effective establishment of working relationships between the different areas of lore. Thus, this experience provided the mutual exchange of knowledge among different areas, and promoted the approach of different segments of the community where the project was developed.

Another interesting feature of the implementation achieved in the development of this work is the flexibility to adapt the computational tools created for other biomedical scenarios. This way, this enterprise can be adapted to other contexts with similar epidemiological characteristics.

Finally, this study can be used as a complement to the overall strategy to map the need for health actions to reduce the number of cases of diseases transmitted by the *Aedes aegypti*. It should be noted in this sense that health systems, along with the sanitary authorities, need to be more resilient regarding the diseases mentioned in this article.

Acknowledgements

This project was fully supported by the Regional University Center of Espírito Santo do Pinhal, UNIPINHAL.

References

1. Santos-Gouw AM, Bizzo N. Dengue in school: contributions to health education in the implementation of a science education project. VII Enpec. Available: <http://posgrad.fae.ufmg.br/posgrad/viiienpec/pdfs/380.pdf>. Accessed in: 28/02/2016 (in Portuguese).
2. Tauil PL. Critical aspects of dengue control in Brazil. *Cadernos de Saúde Pública*. Vol. 18 (3); 2002. p. 867-871 (in Portuguese).
3. Braga IA, Valle D. *Aedes Aegypti*: control history in Brazil. *Epidemiologia e Serviços de Saúde*. Vol. 16 (2); 2007. p. 113-118 (in Portuguese).
4. Forattini OP, Brito M. Household water reservoirs and control of *Aedes Aegypti*. *Rev. Saúde Pública*. Vol. 37 (5); 2003. p. 676-677 (in Portuguese).
5. Braga IA, Valle D. *Aedes Aegypti*: Insecticides, Mechanisms of Action and Resistance. *Epidemiol. Serv. Saúde*. Vol. 16 (4); 2007. p. 279-293 (in Portuguese).
6. Kahn JG, Yang JS, Kahn JS. Mobile Health Needs And Opportunities In Developing Countries. *Health Affairs*. Vol. 29 (2); 2010. p. 252-258.
7. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, Patel V, Haines A. The Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review. *PLOS Medicine*. Vol. 10 (1); 2013. p. 1-45.
8. Sommerman A. The inter and transdisciplinarity. In: *Proceedings of the X International Seminar on Education. Cachoiera do Sul*. Brazil; 2005 (in Portuguese).
9. Piaget J. *Où va l' éducation*. Paris, France: Gallimard; 1988. 116 (in French).
10. Follari RA. Some practical considerations about interdisciplinarity. In: Bianchetti L, Jantsch A. (eds.) *Interdisciplinarity: beyond the philosophy of the subject*. Rio de Janeiro, Brazil: Vozes; 1995. 204. (in Portuguese).
11. Brassolatti RC, Andrade CF. Evaluation of an educational intervention in dengue prevention. *Ciência e Saúde Coletiva*. Vol. 7 (2); 2002. p. 243-251 (in Portuguese).
12. Madeira N, Macharelli CA, Pedras JF, Delfino MCN. Education in primary school as a strategy to control dengue. *Revista da Sociedade Brasileira de Medicina Tropical*. Vol. 35 (3); 2002. p. 221-226.



Jose Tarcisio Franco de Camargo has degrees in Electrical Engineering (State University of Campinas, UNICAMP, Brazil, 1989) and Education (UNINTER, Brazil, 2015), M.Sc. Degree in Electrical Engineering (UNICAMP, 1992) and Ph.D. in Electrical Engineering (UNICAMP, 1995). He works as university professor since 1990, currently being professor and researcher at the Regional University Center of Espirito Santo do Pinhal. His research interests cover the areas of computer graphics, robotics and new technologies applied to education. Contact him at jtfc@bol.com.br.



Eliana Anunciato Franco de Camargo has Degree in Biology (FIMI, Brazil, 1992) and Pedagogy (FIA, Brazil, 2000), Specialization degree in Health Teaching (Federal University of Rio Grande do Sul, UFRGS, Brazil, 2015), Specialization Degree in Distance Education (UNOPAR, Brazil, 2016), M.Sc. Degree in Parasitology (UNICAMP, 1997) and Ph.D. degree in Animal Biology in the area of Anthropogenic Relations, Environment and Parasitology (UNICAMP, 2016). Her interests are in Parasitology, Entomology and Malacology with emphasis in Parasites and Vectors, and in the area of e-Learning. Contact her at eafcamargo@yahoo.com.br.



Estefano Vizconde Veraszto has Degree in Physics (UNICAMP, 2001) and Ph.D. in Education, Science and Technology (UNICAMP, 2009). He also made a supervised Ph.D. internship at Complutense University of Madrid, Spain, 2009. He is currently a professor at the Federal University of Sao Carlos, UFSCar (since 2013), coordinator of postgraduate studies in Science and Mathematics Education (since 2016) and researcher at Technological Innovation Laboratory in Applied Education, UNICAMP (since 2003), and at the Research Group in Natural Sciences Education, UFSCar (since 2013). Contact her at estefanovv@gmail.com.



Gilmar Barreto received M.S. and Doctorate degrees in Electrical Engineering, from UNICAMP, respectively in 1986 and 2002. He has experiences in Electrical Engineering with emphasis on Education Engineering, Industrial Electronics, Systems and Electronic Control: Fuzzy systems, multiple variables systems, control, multiobjective optimization, electrochemistry and Electrical engineering teaching. Currently he is a Professor at UNICAMP, School of Electrical and Computing Engineering - FEEC, Electrical Machines, Components and Intelligent Systems Department- DMCSI. Contact him at gbarreto@dsif.fee.unicamp.br.



Patricia Aparecida Zibordi Aceti has Degree in Technology in Data Processing from Pinhalense Education Foundation (FPE, Brazil, 1991), M.Sc. Degree in Production Engineering from the Methodist University of Piracicaba (UNIMEP, Brazil, 2006) and M.Sc. Degree in Information Systems Management from the Catholic University of Campinas (PUC-Campinas, Brazil, 1999). She is currently university professor at UNIPINHAL, at the City College “Professor Franco Montoro” and at UniFAE (Brazil). She has 25 years of experience in Computer Science. Contact her at patriciazibordi@uol.com.br.



Ademir Salvi Junior, graduated in Pharmaceutical Sciences with license in Industrial Pharmacy (PUC-Campinas, 2003). Postgraduate Specialist in Pharmacology (Federal University of Lavras, UFLA, Brazil, 2005) and Teaching in Health (UFRGS, 2015). M.Sc. Degree in Pharmaceutical Sciences (Sao Paulo State University, UNESP, Brazil, 2009) and Ph.D. in Pharmaceutical Sciences (UNESP, 2013). He works as university professor since 2009 and as Pharmacy Course Coordinator since 2012 at UNIPINHAL. Has experience in the pharmaceutical sciences, with emphasis on Pharmacognosy and Pharmacology. Contact him at salvi_fcfar@yahoo.com.br.