Multidisciplinarity in computer education: a pedagogical experience

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***Abstract* - This article describes a pedagogical experience held in the University of Sao Paulo – Brazil (USP) in the Diversified Studies – Applications of Informatics course. This is part of the School of Arts, Science and Humanities graduation course. The methodology used has been based on the development of projects by small groups, using informatics resources available in the computer laboratory and the Internet. The developed projects were encouraged into inter- or multidisciplinarity and focused on social and humanistic applications. This method was inspired on PBL (problem-based learning). In PBL students are the pivot of the learning process and have the main responsibility in the problem solving process. So, in the described course the students are stimulated to find solutions for their projects by using local and free web-available resources. Good results, an excellent student acceptation and a very good assimilation of concepts and practices have been obtained.**

Index Terms – Computer Education, Multidisciplinary, Problem Based Learning (PBL).

INTRODUCTION

The context this article refers to is the course of *Diversified Studies – Applications of Informatics*. This course is taught to students of the EACH - School of Arts, Sciences and Humanities at the University of Sao Paulo – Brazil (USP). The pedagogical proposal of this USP unit is based on the encouragement to multidisciplinarity, a concept recently adopted in the area of education. There are ten new undergraduate courses in the campus: Physical Activity Science, Geriatrics, Environmental Management, Public Policies Management, Leisure and Tourism, Nature Sciences, Marketing, Obstetrics, Information Systems and Textile Technology and Dressing. Considering the new educational expectations, a single Basic Cycle was created for all those undergraduate courses. In the basic cycle, students from all specialties take a set of courses together, which enforces multidisciplinarity. The main objective of Basic Cycle courses is to teach and to explore general, social and practical knowledge subjects, initially without commitment with none of the specific specialties. Thus, students are directed to focus theirs attention toward the development and application of techniques to solve real problems, keeping always in mind their connection to research activities with social applications.

THE PROPOSAL OF THE DIVERSIFIED STUDIES (DS) COURSE

DS is one of the Basic Cycle courses, available to the students of all the EACH undergraduate courses, in their first academic year. EACH offered, in 2005, three DS courses. Students had to take two of them, one per semester. Options available were: "Applications of Informatics", "Culture, Communication and Creativity" and "Text Production". EACH has certain flexibility to expand, to modify or to update this set of options on need. The aims of the course include the study of subjects in a set of areas, through a modern optics, in order to provide a better general formation to the students, with the possibility to handle themes non-usually explored in traditional courses. Besides, the course tries to stimulate the interaction between students from different undergraduate courses, with a variety of formations, by promoting contact with schoolmates from different classrooms and specialties. This has shown to be an efficient way to put multidisciplinarity into practice. The Diversified Studies course, in its specialty "Applications of Informatics" offers a novel proposal for informatics teaching, mainly for non-specialists. The education method adopted was based on a set of project-development classes – aimed to exercise practice and creativity skills, complemented with conceptual lessons – intended to enforce the fundamentals for the practical component. The course is composed of a sequence of activities directed to the student's familiarization with computers and its resources, which are considered as constant-use tools. Its aim is to prepare the students to be versatile computer users, to efficiently use resources available in the computer and the data communication networks. Another intent is to motivate students to explore the computer and its resources for use on day-by-day personal, corporative and social problem solving. The main characteristics of this method are:

- In-class practical activities;
- Development of complete projects during the classes;
- Development groups with heterogeneously-skilled members;
- Enforcing project specification and use of adequate computational tools to find a good solution for the considered problems;

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- Enforcing self-learning of concepts needed for using the chosen tools;
- Selection of suitable tools to be used in the project;
- Enforce learning practical details of the chosen tools.

With such a differentiated format for the course, our main intent was to eliminate the usual worry in beginners about direct contact with technology.

Additionally, one of the course premises is to stimulate the integration and co-operation with other undergraduate courses, therefore project subjects are encouraged to enclose one or more of the elements below:

- Pedagogical utility;
- Inter- or multidisciplinarity;
- Social promotion;
- Educational contribution.

PROPOSED AND IMPLEMENTED PROJECTS

Initially, some topics have been suggested for the projects, encouraging diversity. Among many other suggestions, the following have been included:

- Video creation and edition;
- Creation of Web pages;
- Non-conventional manipulation of Office-like packages;
- Handling images and drawings;
- Software development with programming languages;
- Database manipulation;
- Creation of multimedia resources.

Starting from such suggestions, the development groups chosen specific subjects and delimited a problem, applying at least one of the above-mentioned topics. In the initial phase, it was observed a preference for developing projects for the Internet, e.g. the creation of web pages with specific contents, web database programming, multimedia and image handling for Internet contents. It is important to emphasize that almost all proposed projects reached their goals and followed the expectations of the course, and most of the developed projects have explored more than one of the above mentioned items. Forty nine projects were developed in the first semester of 2005 by EACH-USP Basic Cycle students. The resulting projects were analyzed and evaluated according to the previously established aims, and the following results were obtained:

- 27.7% of the groups developed useful contents for some specific undergraduate course;
- 48.9% of the developed projects were inter- or multidisciplinary ones;
- 51.1% of the projects had shown some clearly stated social contribution;
- 38.3% included general-purpose, contents-independent educational tools.

Figure 1 illustrates the distribution of the project aims according to the purposes discussed above.

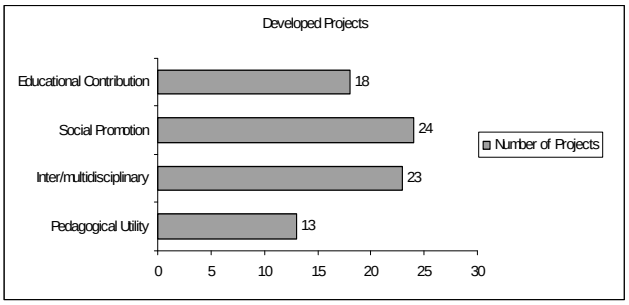

Figure 1: Number of projects corresponding to their aims.

55.3 % of the developed projects had fit at least two of the aims delimited in the previous item. Their distribution is illustrated in figure 2:

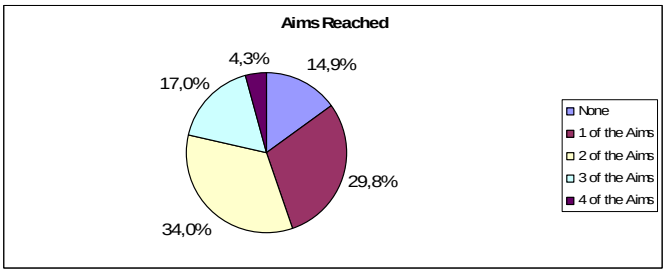

Figure 2: Course aims versus project rates

Figure 3 illustrates the choice distribution for the projects according to the media used in their development. The main choice among the projects has been the design of Web pages, 66% of the groups.

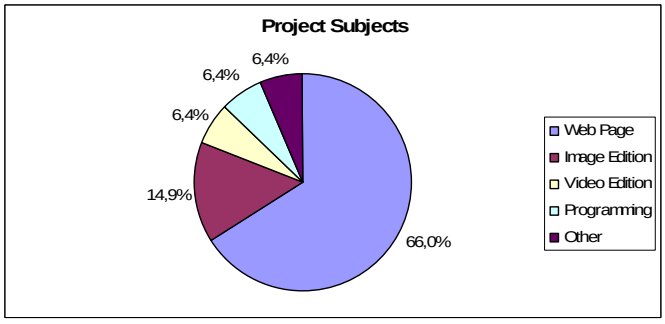

Figure 3: Distribution of projects according to the chosen media.

It is evident the projects developed by the groups fit the course aims and expectations. Moreover, developed projects resulted diverse and assorted, despite the high concentration of Internet-aimed ones, especially due to the freedom of subjects, formats and resources employed in their design.

PROFILE AND EVOLUTION OF PARTICIPANTS IN THE COURSE

Considering that this course is offered to the first-year students, it was observed an expressive number of people with weak computing knowledge. What plays the main role in this aspect is that most students came from schools with minimum access to computers and computing resources. An exception was found in night courses, where most of the students already use computers in their jobs. It was observed that in undergraduate courses about half of the daytime courses

students and the third part of night courses students had insufficient knowledge on using computational resources at the beginning of DS course. While the course evolved, students have frequently been, stimulated to use yet unknown computer resources to develop their projects and other course activities. Naturally, students having little previous computer experience shown slightly greater difficulty to adapt to the method. In contrast, at the end of the course, despite not obtaining the highest grades, they demonstrated an excellent evolution in their accumulated knowledge, showing the best learning performance. Students with more computer skills had been encouraged to work with new computer tools, to explore different technical activities, such as the production of video movies, computer language programming, image editing, etc. This strategy was used with some students in order to induce them to enlarge their skills and to develop new ones by exploring even unconventional ways to use computational resources in problem solving. Almost all students significantly improved their computer knowledge by employing information technology and communication tools in the development of their projects and/or other course activities. By the end of the course, they had proven their knowledge on how to:

- use the most popular software and their main features;
- access and use the Internet in searching and in research activities;
- locate and use services available in the Internet;
- find, install and use free/open source software;
- adapt available software to fit the needs of specific applications;
- use available software on both standard and non-conventional ways;
- use different and independent software programs in order to perform complex operations that require features not available together in a single program.

DEVELOPMENT OF THE PROJECTS AND LEARNING EVOLUTION OF THE GROUPS

During the entire course, the students established a gradual and accumulative learning. The projects were developed in groups of up to four people. Interdisciplinarity was stimulated in the diverse subjects. These projects evolved in five successive phases:

1. Project specification and definition. The students would have to consider a specific subject. They had to establish goals and the way to reach them;
2. Search computational subsidies for the project development, including new software, new functionalities and the basis for the specification;
3. Learning and conducting tests of the chosen software, and its application to the particular case;
4. Project development and implantation;
5. Project documentation and results publication.

The course was performed following such phases. Students developed their activities in the laboratory with practical lessons, each one in an individual computer. The course was designed considering all the project development activities during the classes. At the beginning learning difficulties was higher from the students with few computer skills. This group needed additional time, and help, to adapt to the method. Such students had evolved slowly in the first lessons, due the need to learn how to use the basic computer resources. After this stage, they had evolved faster until get a consistent domain of basic computer operation and the Internet. When considering the students with more advanced computer skills, it was perceived a continuous and gradual evolution, class by class. For this group of students the evidenced result was the modeling of a personal profile flexible and adaptable on the use of computational resources not previously familiar.

RESULTS AND DISCUTIONS

It was applied a feedback form for evaluation of the course with the purpose to collect students judgment about the education method and their perception about the results. Form was composed of 25 general questions about the method, the learning, the students' behavior and the professor. It was answered on-line by 63 students of six different classes, a morning one, two of evening's and three of night. After analyzed the results it was contrasted the students opinion with the professors perception, both was very close. Considering the method, students were satisfied with the lessons and they had a gradual and consistent learning, if compared to traditional computer courses. About this aspect the students expressed a similar opinion to what it was observed by professors. Students view are represented graphically next. Figures 4 and 5 illustrates the students perception about the method. The method was approved by 80% of the students and 74% of them considered it efficient.

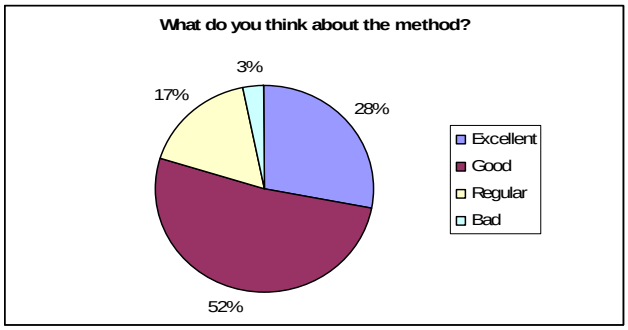

Figure 4: Education method evaluation

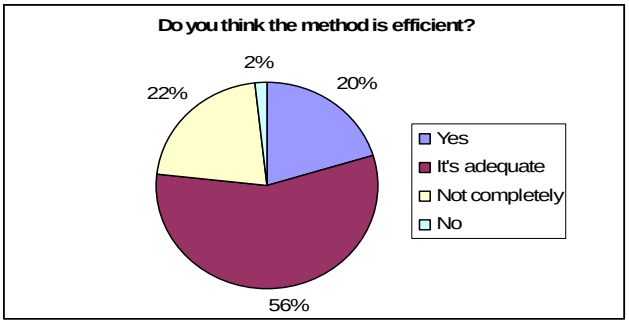

Figure 5: Method efficiency

Data illustrated in figure 6 certify the efficiency of the method. One of the aims clearly covered by the method was to provide

a basic formation in computer using, useful for the student's academic and professional development, independent of its undergraduate course. In this case 74% of them had considered the content developed during the course supplemented their general formation (figure 6).

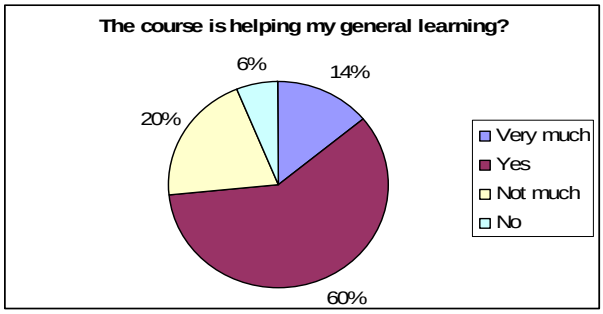

Figure 6: General formation

Figure 7 illustrates the students' autonomy on contributing to their own learning. It emphasizes the course efficiency in preparing them to find out subsidies to solve their particular or general problems in the course.

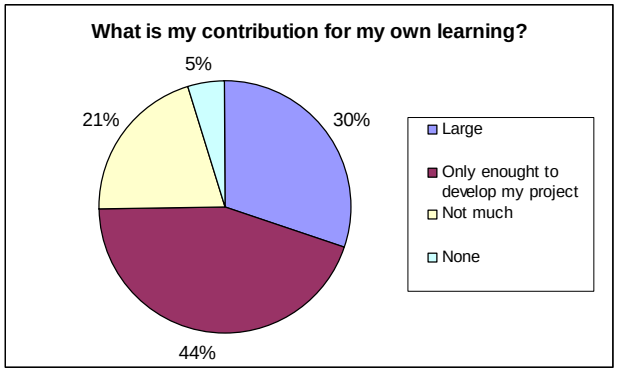

Figure 7: Participation in learning

THE DS METHOD RELATION TO PBL AND ITS APPLICATIONS

Problem Based Learning (PBL) is a method of learning centered in the student, who becomes the active agent of your own learning. PBL detaches a cyclical context for the learning, it promotes the development of abilities to work in group, and also it stimulates the individual study, according to the student interests and rhythm. The student evolves from passive receiver to the main instrument responsible for your own learning. In PBL, the professor acts as tutor (or facilitator) in the groups and has the chance to know the students difficulties and keep closer of them during the entire course [1]. This method demonstrates very positive results developing new abilities in the students [2]. This method was developed and applied initially in health area, mostly in medicine [4] [3] and nursing [6] [5], but currently other areas are also adopting the proposal, adjusting to its specific program of study [8] [7]. Also, there are some papers demonstrating applications of this method in other areas, like engineering [9] and computer science undergraduate courses [8] [10]. The education method described in this article, even so inspired in the PBL, is established under a different focus. The similar characteristics to PBL method are summarized below [4]:

- learning centered in the student, who assumes the main responsibility for your own learning;
- professors act as facilitators or tutor;
- projects development encourage the students to generate abilities on general problems solving;
- new skills are discovered through the auto-learning.

The most important differences of Diversified Studies-Informatics' Applications method and PBL method are summarized below:

- the classes were organized with up to thirty students (or a limit based on the number of computers available in the laboratory);
- the students were organized in groups of up to four elements;
- all the groups were responsible for: delimiting their problem based on any subject, propose a solution and implement it. Activities during the classes help them to find a solution through the searching subsidies in data communication networks and using computer tools;
- the groups, essentially, were formed by students with different abilities from different undergraduate courses;
- the projects were developed during the classes in four phases: 1) problem definition; 2) search of subsidies for the resolution; 3) development; 4) documentation and publication.

CONTRIBUTIONS

The presented method improves the learning process on computer courses, facilitating the access to diversified and updated information. It prepares the student effectively, to handle the most common available software tools, to adapt on using the new technologies, to discover and use free/open source software, it provide them versatility in academic and professional life. This novel learning model drives the student to work not only with the available tools but also to search other subsidies to locate more adequate alternatives to your problem solving. This course model put the students involved with new and rich experiences, through a fast learning; the content is easily assimilated and immediately put in practical.

CONCLUSION

The DS course method, discussed in this article, revealed to be efficient, and the results had been sufficiently satisfactory. Students learning were more permanent and solid, after the end of the course considering the applied concepts and the tools used in the development of the project. An efficient assimilation of practical computer use was also evidenced, as well as the growth of students sensitivity on solving new problems. This presented learning method can be applied to others computer courses taught on traditional way, especially for basic practical courses or in those the student's computer skills are very heterogeneous. An improvement for the method may be proposed: the incorporation of a student interaction tool to share difficulties and to stimulate collaboration. It will

be put available to the students a resource similar to an on-line daily to accompaniment of projects development process and also to offer them other way to interchange information and contribution between the groups.

REFERENCES

[1] Haith-Cooper, Melanie, "Problem-based learning within health professional education. What is the role of the lecturer? A review of the literature", *Nurse Education Today*, Vol.20, 2000, p.p.267–272;

[2] Dochy, Filip; Segers, Mien; Bossche, Piet Van den; Gijbels, David, "Effects of problem-based learning: a meta-analysis", *Learning and Instruction*, Vol.13, 2003, p.p.533-568.

[3] Morrison, Jillian, "Where now for problem based learning?", *Education and practice*, v.363, 2004, p.p.174;

[4] Liu, Min, "Examining the performance and attitudes of sixth graders during their use of a problem-based hypermedia learning environment", *Computers in Human Behavior*, v.20, 2004, p.p.357-379;

[5] Francis I. Achike, Noraini Nain, "Promoting problem-based learning (PBL) in nursing education: A Malaysian experience", *Nurse Education in Practice*, Vol.5, 2005, p.p.302–311;

[6] Cooke, Marie; Moyle, Kadie, "Students' evaluation of problem-based learning", *Nurse Education Today*, Vol.22, 2002, p.p.330-339;

[7] Pearson, John, "Investigating ICT using problem-based learning in face-to-face and online learning environments", *Computers & Education*, 2004;

[8] Green, Carolyn J.; Gyn, Geraldine H. van; Moehr, Jochen R.; Lau, Francis Y.; Coward, Patricia M, "Introducing a technology-enabled problem-based learning approach into a health informatics curriculum", *International Journal of Medical Informatics*, Vol.73, 2004, p.p.173-179;

[9] Lau, H.Y.K., Mak, K.L, "The virtual company: a re-configurable open shell for problem-based learning in industrial engineering", *Computers & Industrial Engineering*, Vol.47, 2004, p.p. 289–312;

[10] Burguna, Anita; Darmonib, Stéfan; Le Duffa, Franck; Wéberc, Jacques, "Problem-based learning in medical informatics for undergraduate medical students: An experiment in two medical schools", *International Journal of Medical Informatics*, 2005;

[11] Carlisle, Caroline; Ibbotson, Tracy, "Introducing problem-based learning into research methods teaching: Student and facilitator evaluation", *Nurse Education Today*, 2005;

[12] Conway, J.; Sharkey, R, "Integrating on campus problem based learning and practice based learning: issues and challenges in using computer mediated communication", *Nurse EducationToday*, Vol.22, 2002, p.p.552-562;

[13] Docherty, Charles; Hoy, Derek; Topp, Helena; Trinder, Kathryn, "E-Learning techniques supporting problem based learning in clinical simulation", *International Journal of Medical Informatics*, Vol.74, 2005, p.p.527-533;