

Mathematics Education into the 21st Century: Improving the Curriculum of Future Teachers

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INTRODUCTION

Digital media are malleable and can be adjusted to different learners; at the same time, network technologies facilitate just-in-time resource selection and delivery. Due to this fact, the Internet can be part of the solution to enhance Mathematics teaching in a student-centered learning environment. In this sense, the Mathematics Education in the 21st Century should consider new technologies like the Internet as a way to improve the curriculum of future teachers of Mathematics.

This article intends to suggest a course in computer based Mathematics for university students specializing in teaching techniques. The proposal is based on a hands-on recent experience in computer based Mathematics teaching and learning discipline that lasted for half a year at Campinas State University LAPEMMEC laboratory.

THE LAPEMMEC LABORATORY

Since 1999, the LAPEMMEC Laboratory², at the Faculty of Education of Campinas State University - UNICAMP, which is coordinated by the author of this paper and has the financial support of FAPESP³, has carried out research in the teaching of computer based Mathematics. This project tries to provide ways and means to investigate how interactive learning scenarios, based on computational environments founded on a constructivist pedagogical conception, can restore, through reflective teachers' education,

a new professional culture, a new logic which is increasingly imposing itself with the introduction and spreading of computers in the social and educational context. The objectives of the Project LAPEMMEC are:

- 1- to offer theoretical-methodological assumptions for reflective and informed education of future teachers in the field of Mathematics Education, regarding the understanding and use of computational environments, thus helping these future teachers to develop a critical view of how technology can be incorporated and used in the context of the classroom to help in the development of mathematical concepts.
- 2-To offer data and pedagogical-cognitive elements to the design of interactive environments based on Simulation computational environments, Tutorials, Problem Solving, Programming Language, AVI Constructor (Animation), Internet, among others, appropriate for the development of mathematical concepts.
- 3-To offer theoretical-methodological data for devising an alternative methodology based on the well informed use of technology by the teachers, thus contributing to a possible new dimension to the process of teachers education and to the process of exploration and construction of mathematical concepts.

Thus, the LAPEMMEC users are encouraged to use the infrastructure available to develop several activities, including content for educational sites which deal, in a certain depth, with a given theme in Mathematics. The participants of LAPEMMEC, by making their sites available on the Internet, create a virtual space of on-line discussion about the contents dealt with while carrying out the projects with the computational environments mentioned above. Through a virtual room called "Mathchat" (MATPAPO), created on the Collabra/Netscape⁴ the participants exchange information and ideas on the creation of the sites; they express their doubts about the format and contents of the sites. We point out that by working under this perspective, we are offering the subjects interactive contexts of shared learning. The interactivity can be understood as one of the most important and fundamental aspects in the process of exploration, construction and representation of the mathematical knowledge, because it is through this

¹ The author thanks to FAPESP for financial support.

²<http://www.cempem.fae.unicamp.br/lapemmec>.

³ FAPESP – Fundação de Amparo à Pesquisa do Estado de São Paulo.

⁴<http://www.netscape.com>.

interactivity that the different views and perspectives relate with one another in order to re-make and re-dimension the knowledge in the technological context.

A DISCIPLINE PROPOSAL

A first discipline in distance learning should have the Internet as the main focus for the reasons already mentioned. Such a discipline is suggested especially for the first semester of the undergraduate courses in Mathematics and Education so as to initiate these future educators as quickly as possible in the new learning paradigm of the Information Society in Brazil. (MCT, 2000).

The constant use of the Internet may cause an individualization in the educational process if the students are encouraged to use it as a research source. The teacher in charge of the discipline should take the role of facilitator, allowing the students to construct the knowledge through the constant use of the Internet throughout the course. We suggest that the teacher prepare some instructional material in the format of a tutorial with the topics presented, which will be used as a reference for the discipline. This tutorial, which can even include videos and animations, should be made available on the Internet at the very beginning of the course to be used as pedagogical support to the students in their learning process.

Some important issues related to the creation of this tutorial are: the creation of a very detailed table of contents; a search mechanism by words so that the reader can immediately refer to the subject of his/her interest; the creation of a hierarchy that can make explicit the main subjects; the creation of a summary that can give the user a global view of everything that will be in the tutorial. The idea is to develop a hierarchy of pages that looks natural and well structured to the user. In the case of an online course, it is suggested that the teacher interact with the students by using synchronous and non synchronous communication, such as: e-mails, chats, video conference, among others. In offline course, we suggest that the teacher teach all classes in a computer lab in order to show examples from the Internet and to demonstrate personally the use of the computational infrastructure available such as digital cameras, CD-ROM and DVD recorders, soft t wares, etc.

In both cases, it is suggested that that the teacher enrich the tutorial with the help of his/her students, by encouraging them to rewrite parts of the text that look unclear or not very well detailed. The students could contribute by accessing the Internet and copying the texts of their interest and sending them to the teacher by e-mail, after having made the changes. The students should contribute as much as possible to the improvement of the tutorial by changing and/or generating contents. The students should see the tutorial as an opportunity to practice the techniques that have been taught. Besides that, the students should be encouraged to form discussion groups about a variety of themes, to look for information on the Internet about the subjects of their interest and to interact using all the possible means.

The emphasis, therefore, should be on encouraging the students to go to the Internet to look for information about essential topics suggested by the teacher and simultaneously use all the technological resources available in order to record and increase their learning.

We also suggest that the teacher in charge generate a data bank about the course including all messages exchanged throughout the course, so that teachers and students in the following semesters can benefit from the statistics gathered. By doing that we hope to improve the quality of the discipline and we also hope that the tutorial can become better every semester the discipline is offered, so as to eliminate or add new topics based on the students' suggestions.

The topics suggested in this paper represent only the themes to be developed in a one semester course with four hours of weekly dedication. It is the teacher's job, in this introductory discipline, to adjust the topics that make up the instructional material to his/her students' reality.

DEVELOPMENT OF THE COURSE BY TOPICS

(1) Introduction:

Whom the course is for; fundamental objectives to be met; how students should behave during the course; instructional material: the tutorial of this discipline available on the Internet; similar tutorials on the Internet; the proposal for constant improvement of the tutorial format; how to contribute to the constant improvement of the tutorial; statistics of the previous courses.

(2) Introduction to distance learning:

What is distance learning; history of distance learning; distance learning regulation; advantages and disadvantages; differences between online, offline and online/offline courses; distance learning as a complementary mechanism, substituting or integrant; the most common means of instruction: texts, audios, videos, CD-ROMs, etc.; synchronism and non synchronism; what is the Internet; the internet as a means of instruction; main free access sites related to education; examples of distance learning courses that do not use the Internet; advantages and disadvantages of using the Internet in distance learning courses; what is globalization; globalization and distance learning; statistics of distance learning in Brazil and in the world.

(3) *Glossary of fundamental terms for the discipline*

Fundamental terms in computer science: software, hardware, etc.; fundamental terms on the Internet: band width, sites, etc.; fundamental terms in distance learning: electronic learning, computer based teaching, etc.; Internet sites with tutorials and /or glossaries related to computer science, Internet and distance learning.

(4) *Searches via the Internet and the virtual libraries*

Possible ways to access the Internet; what are web browsers softwares; What are hypertexts and what is hypermedia; what is download and upload; the relationship between the quality of the Internet connection and the quality of the courses online; what are keywords; what are search browsers; what are virtual libraries; how to use the Internet to search for documents.

(5) *Up-to-date education issues*

What are transversal themes in education; the new technologies as a transversal theme; what are the curriculum parameters and directives; the regulation of the profession and the educator's role in the society; the construction of knowledge; the "learning how to learn" paradigm; the development of creativity; the teacher facilitator, the self-taught learning and distance learning courses; the role of the educator in distance learning courses; the virtual reality as a learning environment; the development of efficient methodologies for distance learning; the development of appropriate tools for individual or group study through the use of new technologies; other updated educational issues in Brazil and in the world.

(6) *The impact of computers on education*

The capacity for numerical processing (weather forecast, etc.); capacity for symbolic/logical processing (desktop publishing, specialist systems, etc.); the capacity of multimedia interaction (interaction via images, sounds, etc.); the capacity to control and command concrete actions in the real world (satellites, robots, etc.); the capacity to interlink computers and people in distant places altering the relationship space/time between teachers and learners; ways of using these capacities in the Internet based teaching (cooperative development of projects and instructional materials by teachers geographically spread out; teaching resource sharing among institutions; etc.).

(7) *Brazil and digital exclusion*

What is the Information Society Project in Brazil; what is a society of knowledge; what is a digital society; what is digital exclusion; digital exclusion and the domain of foreign languages; the difference between technological literacy and technological fluency; what is employability; globalization and employ ability; statistics about employability; statistics of distance learning via the Internet and digital exclusion ; the fundamental professions in the information society.

(8) *Means of communication*

Traditional means of communication: telephone, letter, etc.; means of communication related to digital technologies: e-mail, chat, videoconference, etc.; advantages and disadvantages of the digital means of communication in distance learning ; how to use emails: email account opening, file attaching, etc.; how to use other digital means of communication.

(9) *Fundamental soft wares for creating and maintaining homepages on the Internet*

Programming languages and CASE tools (Computer Assisted Engineering Software); the desktop publishing and the Homepages editors on the Internet; content formatting appropriate for the Internet ; the most commonly used HTML , XML, and JAVA editors, etc. ; the different types of content: texts, videos, animations, etc.; how to use the computational environments to

generate content; advantages and disadvantages of computational environments to generate content; how to develop computational environments to generate content; the contents format and the use of Internet navigation soft wares; soft wares for upload; maintenance of courses and Internet homepages; common problems related to the generation of contents; the data bank and common problems related to the storage of contents; common problems related to making the contents available; access and safety.

(10) Management Systems for online education

What are management environments for online education: advantages and disadvantages. How to use these environments in the educational context.

(11) Defining the public and its learning characteristics

Possible age groups; possible occupations; the different needs of each group; psychology and pedagogy and how it relates to distance learning; how to adapt the same content to different kinds of public; the personalization of the content and of the interface to access the content; how to use statistics to find out the best teaching practices for each public.

(12) Creating online education courses

Defining the target public / audience; defining the content; adjusting the content formatting

to the infra-structure available for the target public; looking at the possibilities of personalizing the contents by organizing the online course in independent topics; the use of previous tests in each topic of the online course so as to identify which subjects the student already knows well; the preparation for the possible need to update the content of the courses; the flexibility of the courses online: how to keep an online course updated and relevant; follow-up of learning and continuous performance evaluation; how to encourage study habits; encouraging the interaction between students of the same course online: e-mails, chats, etc.; ways to evaluate the quality of the course; the linear learning and the printed traditional books; the links, the Internet and the non-linear learning; how to integrate the new technologies with the student's reality.

(13) The cost

The costs and the benefits of the several possible connections with the Internet; software costs; the use of free soft wares in education; the costs of hardware; TCO ("*Total Cost of Ownership*"): the total cost of maintaining a computational infrastructure; ASP ("*Application Service Providers*"): software hosting, the application service providers and the payment of fees to use the applications; reusing the courses online; cost wise effective solutions for distance learning and for online/offline education where the student is present only some of the time: the economic problem.

(14) Quality Management in educational services via Internet

What is quality; what is quality in education services; how to manage quality in education services via Internet; soft wares for quality management in education services via Internet; information systems for education management: what are information systems for education management: how to use them; large scale computer assisted projects .

(15) The businesses related to education without frontiers and learning for life

The market segments for electronic learning; characteristics and examples of corporative training; finding out new markets for distance training; how to make a profit by creating courses ; how to outsource the creation of the courses ; the electronic commerce and the potential profit by exporting courses; marketing: how to market the courses; the virtual universities; the authoring problem and the reuse of content by other authors.

(16) Interaction man/machine

What is an interface; what is an interface that can be personalized; what is an intelligent interface; what are agents ; advantages and disadvantages; how the interaction can become more explicit and efficient ; how the interfaces can offer better support for the users' plans, objectives and tasks; how the information can be offered more efficiently; how to make the design and the implementation of the quality interface more friendly ; the ergonomics of the computational infrastructure and the effectiveness of computer assisted learning.

(18) Trends in distance learning

The present Brazilian government and world priorities ; UNESCO and OECD projects; the main addresses on Internet sites that deal with distance learning trends in Brazil and in the world; the main periodicals about distance learning in Brazil and in the world; the main events in the field of distance education in Brazil and in the world; the present situation and the trends in Brazil and in the world.

(19) Review and debate about the fundamental issues dealt with throughout the course.

Project presentation (summary of all the activities carried out by the students either individually and/or in group); opinion survey among the students in order to identify possible improvements in this introductory discipline; debate about fundamental issues to be included in the next course.

FINAL CONSIDERATIONS

We should try to achieve not only the end of the technological “illiteracy” in Brazil, but also the “fluency” in information and communication technologies . The citizens integrated with the Information Society in Brazil must be able to reformulate knowledge and to express themselves creatively and accordingly in the same way that they should be able to produce and generate information, and not merely understand it . The complexity of modern life and of the computational systems brings critical importance to education .The educators and, in special, those specialized in distance learning via Internet, have a fundamental role to play in this context.

The construction and distribution of technological approaches to support distance teaching at low cost and in large scale geared towards the Brazilian reality so that all educators can have access to those educational technologies, brings once again the need to introduce disciplines related to distance education in the teachers’ education courses. The present paper tries to contribute to the debate on teachers education by suggesting a discipline on distance learning as the main focus of the Internet, as a favorable context to cooperative learning and shared knowledge.

BIBLIOGRAPHY

- ALMEIDA, M. G. M. **Formação de Professores na Modalidade de Educação a Distância: Análise Inicial de um Percurso**, VII Congresso Internacional de Educação a Distância, <http://www.abed.org.br>, Agosto, 2000
- FROSSARD, V. C. **Há Informação Relevante na Internet para o Ensino Fundamental no Brasil?**, III Encontro Nacional de Pesquisa em Ciência da Informação, Rio de Janeiro, 10 a 12 de setembro, 1997
- GILL, C. **Science Education Ahead?**, Phys. Educ., 34, N.º 1, Internet: <http://www.klc.ac.uk/education>, Janeiro, 1999
- JACKSON, G. e KARKI, V. **Computer Software Development: An Export Industry for Developing Countries**, disponível em Janeiro de 2001 no endereço <http://www.TechKnowLogia.org>, TechKnowLogia, Julho/Agosto, 2000
- KUSUNOKI, F. e SUGIMOTO, M. e HASHIZUME, H. **Towards the Integration of Physical and Virtual Worlds for Supporting Group Learning**, Digital Cities, Lecture Notes in Computer Science, Volume 1765, Springer, 2000
- LA INSIGNIA, **ONU quer ajudar países pobres a diminuir a Exclusão Digital**, Folha de São Paulo, 20 de Junho, 2000
- MCT **Sociedade da Informação no Brasil** - Livro Verde, MCT - Ministério da Ciência e Tecnologia, Governo Federal do Brasil, Brasília, Setembro, 2000
- MEARES, C. A. e SARGENT, J. F. **The Digital Work Force: Building Infotech Skills at the Speed of Innovation**, Technology Administration, Office of Technology Policy, U. S. Department of Commerce, Junho, 1999
- OLIVEIRA, E. H. T. e SCAPIN, R. H. e VICENTINI, W. B. **Proposta de um Ambiente Hiperídia Integrado para o Desenvolvimento de Cursos a Distância**, VII Congresso Internacional de Educação a Distância, <http://www.abed.org.br>, Agosto, 2000
- PETERSON, R. W. e MAROSTICA, M. A. e CALLAHAN, L. M. **Helping Investors Climb the e-Learning Curve** - The Next Internet Investment Opportunity, U.S. Bancorp Piper Jaffray Inc., disponível em Dezembro de 2000 no endereço <http://www.piperjaffray.com>, Novembro, 1999
- SETTE, S. S. e AGUIAR, M. A. e SETTE, J. S. A., **Licenciatura em Informática** - Uma Questão em Aberto, Revista Brasileira de Informática na Educação, <http://www.inf.ufsc.br/sbc-ie/revista>, nº 1, Setembro, 1997
- SHNEIDERMAN, B. **Designing the User Interface** - Strategies for Effective Human-Computer Interaction, Addison-Wesley, 1998
- SMOLENSKI, M. **The Digital Divide and American Society** - A Report on the Digital Divide and Its Social and Economic Implications for our Nation and Its Citizens, <http://gartner4.gartnerweb.com/public/static>, Outubro, 2000
- URDAN, T. A. e WEGGEN, C. C. **Corporate e-Learning: Exploring a New Frontier**, Equity Research, WR Hambrecht + Co, Março, 2000
- VOLI, E. **Internet e a Nova Convergência**, Jornal Gazeta Mercantil, Ano LXXX, nº 22013, 1º/Fevereiro, 2001