

IMPROVING THE QUALITY OF TECHNOLOGICAL EDUCATION: A PARTNERSHIP BETWEEN UNIVERSITY AND TECHNICAL SCHOOLS

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Abstract — A project for the improvement of the Quality of the Technological Teaching is considered in this paper. The project involves a partnership between a School of Engineering and two Technical Secondary-level Schools. The project encompasses two main phases, each one with a period of two years for its development. The main results of the first phase, already concluded, are described and a reflection on the actions proposed for the second phase is included.

Index Terms $\frac{3}{4}$ New Technologies in Education, Methodologies and Teaching Techniques, Multimedia didactical prototypes.

INTRODUCTION

Since 1998 we have been working on a project which aims at investigating how the new technologies, in special those one from the field of Informatics, can contribute to the improvement of the secondary-level (technical) education. This project is supported by FAPESP (a Scientific Foundation of the State of São Paulo, Brazil). The project involves the partnership among the University and two public technical schools, at secondary level - the partner schools.

The project comprises two major phases. In the first one, from June 1998 to May 2000, we have worked on several aspects such as the diagnosis of the situation in the partner schools, the implantation of the project, the training of the scholarship-holder teachers, the development, application and evaluation of the didactical software prototypes.

In the second phase, which began in June 2000 and will last until May 2002, we are primarily interested in consolidating the results obtained so far. For the purpose of conducting this phase, we proposed a number of actions such as development and application of the didactical software prototypes; evaluation of the new teaching techniques and methodologies; analysis of the contents of the prototypes; training activities and workshops, amongst others.

In this paper we will summarize the results obtained in the first major phase of the project, referring to papers previously published concerning its development. Then we will make a reflection on the actions proposed for the consolidating phase (the second major phase) of the project, presenting the results obtained so far.

THE FIRST PHASE OF THE PROJECT

We will summarize in this section the most important aspects of the first phase of the project [1,2,3,4], emphasizing its objectives, implanted infrastructure, methodology and main results.

Objectives and Proposed Actions

There are three teams involved in the project, namely: the team of the teachers from the University – the research team, the team of the teachers of the partner schools and the support team. The research team is constituted by teachers from Engineering Courses held in the campus of Guaratinguetá of UNESP – São Paulo State University. This team is responsible for the general coordination of the project. The teachers of the partner schools are responsible for experiencing new teaching methodologies and for the application of the evaluation instruments. They work in the project as scholarship holders from FAPESP in the subjects of Electro-electronics, Digital Systems, Design and AutoCAD. The support team helps with the development and application of the didactical prototypes.

The following were the objectives proposed to the development of the project:

- To characterize an appropriate way of introducing new pedagogical methodologies that lead to the operative and interactive knowledge, using technologies of multimedia and computer science.
- To reformulate the techniques applied in classroom and laboratories in the transmission of knowledge.
- To qualify the teachers in the use of the existing technologies: microcomputers, educational softwares, projectors, amongst others, and to take advantage of the available equipment in a diversified and creative form.
- To evaluate the impact of the use of new methodologies, tools and the qualification of the teacher on the improvement of the quality of technical education.

These objectives were to be pursued through the development of the following activities:

1. Diagnosis and analysis of the current situation of the partner schools and of their necessities.
2. Detailing of the project.
3. Training of the support team.

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4. Development, training of the teachers of the partner schools, application and analysis of prototypes of type I (in which presentation softwares are used).
5. Selection, adaptation, training of the teachers of the partner schools, and application and analysis of prototypes of type II (using educational material from the market place).
6. Planning, development, production, training of the teachers, application and analysis of prototype of type III (using educational material with own development).
7. Evaluation and permanent feedback of the project.

One important element of the project development is the construction of didactic prototypes. Even though that they are essentially software-like prototypes, our definition has a broader sense. In this way a prototype can include methodologies and techniques, and it is not necessarily strongly dependent on software resources.

Implanted Infrastructure

To develop the current project (and other similar ones), we have implanted, in the University Campus, the LET – a Laboratory for Technological Teaching. It includes several rooms, described in the sequel, all of them with appropriate computational resources.

The audiovisual room – projection and video

This is essentially a projection room, in which the teacher can project the slides (or the “screens” as they usually call them), which integrate the didactical prototype developed to give support to the teaching activities of a specific subject matter.

Besides using the projector, the teacher can use a projection table, an apparatus connected to the computer that allows him to project objects such as book pages, electronic parts, and so on, and a video-cassette.

The Microcomputer Laboratory

In this room there are 20 microcomputers, network-connected, which are used for classes in which the students are supposed to work either using specific prototypes, developed to the subject matter, or using appropriate application software (Electronics Workbench and AutoCAD, for instance). Sometimes they are also allowed to make researches in the Internet. Besides the microcomputers, there is a digital flipchart available to support the teacher in his/her classes.

The Support room

An important characteristic of the partnership between the University and the technical schools is the fact that the teachers from the partner schools are supposed to participate in both the design and the development of the software prototypes. Notwithstanding this fact, they are encouraged to ask for help from the support team with respect to specific

aspects such as development of animations, video capturing, image editing, etc.

The Teachers room

In this room the teachers can work on their prototypes, techniques and methodologies. Also in this room they can receive their students, and even take part in meetings.

Methodology and Development

In terms of the methodology for conducting the research, we have proposed the hypothetical-deductive method, which includes three main stages: the appearance of the problem, the proposal of a solution to it, and the corroboration of the proposal. For both reaching the proposed objectives and resolving the problems, we have made an option by the PDCA (Plan, Do, Check and Action) management method.

The development of the project must occur through the continuous improvement of the processes, making them compatible with the advances in knowledge, necessities and expectations of the internal and external clientele, in a way to assure the accomplishment of their ends and guidelines.

Overview of the results

In this section we will refer to the objectives of the project as well as to the activities established for its first phase.

On the project objectives

With respect to the first objective of the project – to investigate an appropriate way for the introduction of new pedagogical methodologies – we can mention that the emphasis with respect to the implantation of new methodologies was in the planning of the activities of the classes, including in those ones the utilization of new technologies. That is, the objective was not to have all the contents of a subject matter in an informatics-based prototype, but to use the new technologies in classes, in a systematic way, coherently with the planning.

With respect to the second objective of the project – reformulation of the techniques applied in the classrooms and laboratories – we can point out that the LET space has been used in three different ways: (i) Using the audiovisual room, in which the classes are normally presented from the projector or the document table, both connected to a computer. (ii) Using the Laboratory of Microcomputers, in which the students work directly on the microcomputers, supervised by the instructor. And (iii), using, jointly, the projector as well as the microcomputers, in the Laboratory of Microcomputers. In any of these spaces, the teacher can use a conventional board.

With respect to the third objective – the qualification of the scholarship-holder teachers in the utilization of the new technologies – the research team worked in the planning and realization of appropriate training activities, applied to the teachers. As a result, nowadays most of them dominate basic and simple tools, appropriate to the development of “electronic classes”, in the form of didactical prototypes.

With respect to the fourth objective – evaluation of the impact of the new methodologies, techniques and of the teacher qualification – the research team has acted essentially in three aspects, namely (i) conducting weekly scheduled meetings with the scholarship-holders teacher; (ii) constructing and promoting the application of evaluation questionnaires, applied to the students of the subject matters considered in the project; and (iii) monitoring some of the classes and even filming portions of them.

On the activities of the project

The initial phases of the development of the project comprised the diagnosis of the situation of the partner schools, the detailing of the project and the planning/application of the training (qualification) activities for all the teams of the project. Next, the objective was, with respect to the didactic prototypes, their development using appropriate softwares, the training of the teachers of the partner schools in their use, their application in a routine situation of teaching, and their analysis. The evaluation phase was initiated after the application of the prototypes, aiming at the permanent feedback of the project.

Diagnosis and Training

The activity of diagnostic of the situation in the partner schools had a bigger involvement of the coordinators of the partner schools, for the reason that they are plenty of knowledge of the reality of their respective schools. Therefore, they have been responsible for the survey and systematization of the data for the composition of the diagnostic. According to [6], the activities of diagnostic and detailing of the project define the stage of “Characterization of the Problem”.

With respect to the training activities [2], following [7], they have been organized taking into account the development of formal capabilities, classified as technical, pedagogical and relational. The technical capability embodies the theoretical and practical knowledge of the subject matter, required from someone teaching it. The pedagogical capability involves both the questions of didactical communication, in the context of the contents of the subject matter, and the comprehension of the roles and real abilities needed to act as an educator. The relational competence is “turned to the development of abilities for the work in teams, participation in the decisions, resolution of problems, elaboration of interdisciplinary projects, diversification of strategies, implementation of actions for the curricular development, evaluation of processes and of academic results, as well as evaluation of educational projects and of curriculums”.

Evaluation: Instruments and Tools

In essence, we have been using evaluation questionnaires of two kinds: one for the survey of the scholarship-holder abilities, and another, applied to the students of the classes involved in the project. The questionnaires applied to the

students are of two types: one questionnaire intended to assemble data concerning the view of the students on the new techniques and methodologies adopted by their teachers in the project, and questionnaires of a second kind, intended to collect data related to (i) the technical details of the prototypes and other resources used in the classes, and (ii) to methodological aspects of specific subjects. In the structuring of our questionnaires, we have followed [8,9].

The survey of the scholarship-holder abilities, since its first application, has been of importance to the research team to have a more precise view of the profile of the teachers of the partner schools.

The questionnaires applied to the students have been of importance to the research team to have a better idea of the impact of the project on the partner schools, and, the most important point, to have elements to feedback all the process, taking into account the objective of continuous improvement, established to the project development.

To deal with the answers given by the students to this and to other questionnaires, we have been used a software tool called SPA [10,11] – a system for supporting the research and evaluation of indicators. With this software, for each relevant factor identified, an appropriate index value, called IDF – Index of Performance in a factor, is calculated.

The didactic prototypes

The application of the first software prototypes has begun in the first semester of 1999. To implement the prototypes, the scholarship-holder teachers have made use of the resources made available by the project (hardware and software), and even of other resources, from other laboratories of the campus.

We have encouraged the use of the Visual Class environment as the authorship software for the structuring of the classes, considering its simplicity and its broad utilization in Brazil at the moment. The Visual Class presents some advantages, including, for instance, facilities for the preparation of exercises (evaluation), allowing the construction of a small evaluation database from the tests answered by the students, and allowing the activation of other programs from a class in the Visual Class. Moreover, the environment of the software displays a menu of classes, being in this way closer to an application turned to support teaching activities.

However, much of the produced didactic material has been developed using the PowerPoint software. As several teachers have felt themselves at easy using the PowerPoint, the research team did not set any objection to its utilization in this stage of the project. Besides, the Director authorship software has also been used in one of the prototypes.

The working teams of the project have developed three prototypes: one for Electro-Electronics [3], other for Digital Systems and other for Auto-CAD [5]. Besides, there are scholarship-holder teachers working on didactic materials for the subject matters of Design and Automation.

The materials corresponding to the first three prototypes above-mentioned have been recorded on CD-ROMs, one for each prototype, which constitutes one of the results of the project, even though that the produced CDs cannot be taken as final products.

Planning the classes: when to introduce changes in the pedagogical practice?

The scholarship-holder teachers are supposed to elaborate a systematic planning for their classes, making use of an appropriate instrument [12]. The planning of the classes are constructed every two months.

The use of the new technologies must appear in specific moments in the planning. That is, the objective was not to have all the classes of a teacher converted to computer programs, for application either using the projector and the canvas, or for direct use in the Laboratory of microcomputers of the project, in a kind of conducted study. The development should emphasize the use of the prototypes in specific moments of the planning (of the classes), supporting the teaching of differentiated topics of the considered subject matters. The topics could be chosen, for instance, based on the results of the evaluation by the students.

Spreading of the Project Results

We have managed to publish the main results of the development of the project through technical papers, talks, participation in events in the partner schools, revision and maintenance of the pages of the website of the project, which can be accessed in the URL <http://www.feg.unesp.br/let/index.html>. This site, which is still in construction, should reflect the current development of the project.

Leading Questions

The evaluation of the project should be done from the teachers themselves, students and, depending on its evolution, the companies of the region, since it would be approached questions related to changes in the pedagogical practices and the expected impact on the market place. In the current stage of its development it would not be possible to involve the companies. Another important aspect for evaluation [13] is to consider also the community in which the project is inserted. Among the questions to be investigated, the following ones have proposed:

- What is the role of the new technologies in the teaching-learning process?
- In what way those technologies contribute for the construction of the teaching by the teacher?
- In what manner the new technologies, in conjunction with a pedagogical proposal, having a constructivist orientation, can favor both the conceptual and practical growth of the students?
- What are the best moments for the introduction of the new technologies in the daily work in the classroom?

- What are the main changes observed in the teachers with respect to the concepts boarded in the classroom?

The above-mentioned questions have been considered as points for reflection during all the project development.

THE SECOND PHASE OF THE PROJECT

In this phase one intends to consolidate the Project. The hypothesis that continues permeating the works is the necessity of incorporation of new technologies, Informatics and Communication resources in the Educational Process.

The proposed activities are related to: improvement of the prototypes generated in the first phase, creation of new prototypes to subject matters already belonging or to be incorporated to the project, and implementation of punctual experiments in some subjects using multimedia resources.

To be able to give continuity to the process of continuous evaluation, it is necessary to propose also other two activities: one that deals with the application and evaluation of the methodologies of the prototypes, and other that analyses the contents and the structure of the prototypes, under a broader vision, extrapolating the context of the two partner schools, aiming at verifying the possibility of the absorption of the prototype in other similar schools.

In the flow diagram presented in Figure 1 one can verify the existence of two other activities: the first one subsidizes another process of creation of new methodologies and/or concludes a productive cycle of the prototypes, allowing the spreading of the results and the transfer of experiences, and the second one, simultaneously to the others, besides doing the documentation, plans and executes the sequence of continuous formation of the scholarship-holder teachers of the project, namely the training.

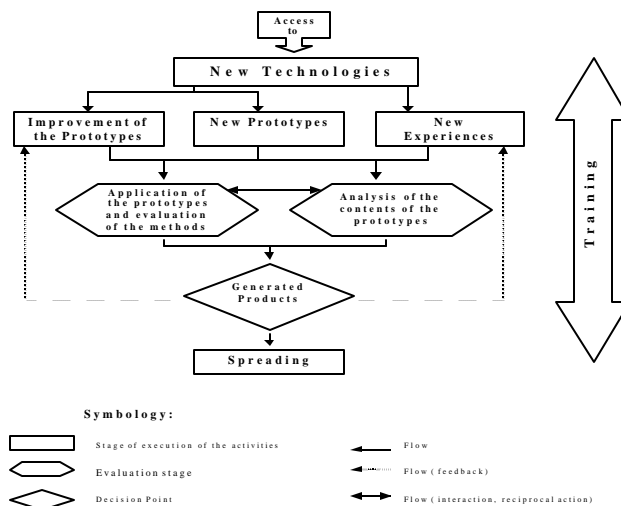


FIGURE. 1
Flow Diagram corresponding to the Second-Phase of the Project.

Proposed Actions

The activities proposed to the second phase can be undertaken as subprojects that do not present themselves as isolated ones. The interdependence among those activities can be observed in the process of creation, application, evaluation of the prototypes, and in how they are related to the activities of continuous formation and spreading of the developed methods and prototypes. In short, in this phase we will emphasize the following activities:

1. Development of the didactic prototypes.
2. Application of the prototypes and evaluation of the new methodologies and teaching techniques.
3. Analysis of the contents of the prototypes.
4. Experiences with respect to the utilization of new resources.
5. Trainings to the teams of the project, generating printed material.
6. Documentation, spreading of the results of the project, and transfer of the experience.

Development

The proposed subprojects are detailed in the sequel, but it is important to stress that for the development of the foreseen activities all the people integrated in the project act in several work initiatives, exactly by the fact that there exists interdependence among them. So, a scholarship-holder author of a prototype will be the one who will apply it, the scholarship-holder teacher presenting himself as a spreader agent of a new technology when he has to pass (transmit) the instruments and tools apprehended to other teachers not engaged in the project.

Development of the Didactical Prototypes

With this activity we propose to give continuity to the development of each prototype, coherently with the guideline of continuous improvement of the project. To this proposal, each team has to do a reflection on what has been done to identify possible extensions or improvements, taking into account new knowledges, evaluation results and other relevant factors.

The development of the prototypes will have to be linked to new methodologies and teaching techniques, which are supposed to be investigated and proposed..

Application of the prototypes and evaluation of the new methodologies and teaching techniques

In the beginning of the project it was observed a certain opposition (resistance) to the application of the prototypes or, equivalently, to the utilization of the new technologies to support teaching activities. Though that opposition has diminished, it is still present, sometimes indirectly through observed behaviors, which can generate risks that can jeopardize mainly with respect to the consideration of the prototypes as final products and in this way neglecting the role (commitment) of personal change, within the process of

introduction of new technologies and teaching techniques. In this sense, we have tried to make the teacher aware of the fact that the education must be a dynamic process and that, for this purpose, in a coherent way with the planning, the teacher must always ponder the possibility of effecting adjustments and improvements.

Therefore, to the improvement of the prototypes, they must be applied and, in addition, that application should be evaluated, so that a feedback of the project can take place. The evaluation tools should be reviewed and adapted to the conditions existing at the moment of their application. The evaluation is considered as a continuous process to verify the effectiveness of the established proposals and of their implementation in different educational contexts. In this analysis one should take into account not only aspects related to the costs, as well as the results obtained with the learning.

Analysis and adaptation of both the contents and of the structure of the constructed prototypes – external evaluation

The main source of information to feedback the project has been the students themselves through the evaluation questionnaires. One intends with this activity to take the analysis of those prototypes under a more general view.

In this way, one wants to analyze the contents of the prototypes under two distinct aspects. The first refers to an analysis carried out by the involved team itself, working in conjunction with both the research team and the support team, aiming at verifying its appropriateness, taking into account a number of factors such as whom it was intended for, the utilized resources, the contents and the basis under which it was constructed.

The second aspect is the external evaluation. One intends to identify external collaborators, from similar areas, that can “run” the prototypes and contribute issuing critics and suggestions.

Those evaluations should pay attention to the factors related to the development of a methodology that contemplate the cognitivism. The difficulties found with respect to the adoption of a cognitivist practice are notable as long as the strong specific technical formation contributes a lot to the utilization of practices of the radical behaviorism.

Experiences with respect to the utilization of the new Technological Resources

With this activity, one aims at proposing and implementing some experiences using instrumentation equipments, a video-conferencing system and the network technology. The experiences will be defined in conjunction with the scholarship-holders teachers, since they have the technical knowledge from their subject matters.

One intends to use some instrumentation equipments – Digital Oscilloscope, Signal Generator, Frequency Generator, Digital Multimeter, Power Supply – as well as the software HP VEE 5.0, educational version. Also, one

intends to use a small video-conferencing station, implanted in the first phase of the project.

It is not possible, with a small number of equipments, to think about its utilization for classes in which the students work directly on them. However, it is possible to think about its utilization in conjunction with the video-conferencing apparatus, for instance for demonstrations or for the accompaniment of some experiences.

The importance of the Internet nowadays is unquestionable. A long-term objective of the project related to this activity is the investigation of pedagogical models based on learning environments mediated by the Internet. These learning environments provide mechanisms for the apprentice to take access to the didactical materials without the restrictions of time and space.

Training to the teams of the project, with the generation of printed material

The training process cannot be understood as a stage defined in a specific time, but as a dynamic process, continuous, oriented by guidelines established from both the teacher profile and from the quality of the teaching. Therefore, it can be necessary to apply new training to the project teams, as soon as that necessity is identified.

With this activity, one intends, in general, to organize trainings oriented to the three competence areas, namely: technical, relational, and pedagogical. In this way, the scheduled trainings should approach themes integrating the mentioned competence areas, filling the gaps identified during the development of the project. As a result of this activity it will be possible to produce, in principle, texts of interest to the professionalizing educational system.

Spreading of the results of the project and transfer of the experience

For the purpose of spreading and transferring the experience, one intends to continue the spreading through talks, reports and the publication of technical papers. Besides, one intends to keep up-to-date the web pages of the project, as they constitute a place from which one can obtain general information about its development.

General Remarks and Conclusions

Two important aspects observed in the scholarship-holder teachers are the initiative and interest aroused in a number of them, as a consequence of their participation in the project. We observe that most of the teachers now evidence more willingness to face challenges and more dexterity to work in teams. Also, their vision of the administrative structure of the school has changed, in terms of effectiveness and participation.

Notwithstanding the efforts to prepare the teachers to the aspects of evaluation, emphasizing instruments, measures, etc., we still note yet some resistance to the evaluation, in

particular, for instance, with respect to external evaluation of the developed prototypes. Also, they still demonstrate some difficulty in differentiating methods and techniques, even though most of them make use of several resources in their classes.

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