

TEACHER TRAINING THROUGH THE  
SOLUTION OF A BIOTECHNOLOGICAL  
PROBLEM IN A COMPUTER SUPPORTED  
COLLABORATIVE LEARNING  
ENVIRONMENT

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**Abstract**

The social impact that biotechnology has in schools demands that biology teachers be constantly up to date. While looking for training proposals, teachers search for strategies that allow them to introduce biotechnology concepts in their classroom in an innovative way. In order to give an answer to this need, we designed a teacher training course on a biotechnology subject: transgenic plants. The strategy implemented was problem-based learning (PBL) in a computer supported collaborative learning environment (CSCL). The course focused on the resolution of an open problem in which teams of four people worked in a collaborative way. Each person had to fulfill a specific role in

the resolution of the problem. The results of the application of this experience and some teaching considerations are discussed in this article.

**Key Words:** Biotechnology, Problem based learning, Computer Supported Collaborative Learning, Teacher Training

## **Introduction**

Recent advances in the area of Biotechnology have had an impact on society leading to important debates regarding decisions taken about problematic situations. A subject with particular repercussion in mass media is food derived from genetically modified organisms (GMOs). According to Marchant and Marchant (1999), society needs to participate in these debates to increase the real benefits that this technology could bring, as well as to reduce or even remove potential risks. However, some studies show that misconceptions about GMOs remain, and that people often repeat messages imposed by some sectors of the mass media, without understanding the biological processes involved.

The introduction of biotechnological controversies in school requires that teachers be constantly up to date in biotechnological, pedagogical, and didactic contents. When analyzing biotechnological applications, it is necessary to take into account arguments derived from different sources (economic, ethical, social, cultural, and scientific); didactic strategies widely used for these ends are debates (Simonneaux,

2002; Sadler and Zeidler, 2004) and case studies (Dori et al., 2003). While looking for continuing education proposals, teachers do not ask for just theoretical issues but are interested in learning about strategies that would allow them to introduce biotechnology concepts in an innovative way in their classrooms. However, in general, training proposals for both science contents and didactic strategies focus on their theoretical bases. In order to cope with this problematic situation, we designed a teacher training course on a biotechnology specific subject, transgenic plants, that would make teachers «live» an approach and gain practical and theoretical knowledge both on the subject matter and on the didactic strategy. The strategy used was Problem Based Learning (PBL). Mediating structures, based on Information Technology and Communication (ITC), were also used.

PBL is a didactic strategy in which teachers act as facilitators. One of the ways in which PBL can be implemented is by organizing learning through small collaborative teams that work to solve a problem (Torp and Sage, 2002). As in any method that makes use of the solution of a problem, in PBL it is necessary to reproduce situations that require the development of hypotheses for the solution, the analysis of results, and the necessary reconsideration of the case. However, PBL usually requires that problems be designed to guide students to carry out searches as well as to gain theoretical and practical knowledge in order to reach a solution. This learning is not limited to content but it also includes the development of transferable intellectual skills, which could be described as collaboration. Genuine

collaboration is produced when students are faced with an assignment that requires real and positive interdependence among the members of a group (Johnson and Johnson, 1976). Therefore, PBL allows students to establish self-generated substantial connections between new information and prior knowledge. As a consequence, these connections are perceived as not being arbitrary, which allows the understanding of contents. If the problem to be solved is meaningful, it causes a positive affective attitude in students and motivates them. Besides, through working in collaborative groups, conditions for social learning are created as a result of the communicative interaction between the students' peers and tutors (Hmelo-Silver, 2004).

Drawing on PBL, a problem about transgenic plants was presented to working teams for them to solve. In these teams, every person had a different role. In PBL, students make their own decisions about what information to gather and how to analyze and evaluate it, which allows each student to participate according to their learning style (Chun and Chia, 2004).

Furthermore, when this type of learning is mediated by ITC, it takes on particular features that are explained through the Computer Supported Collaborative Learning (CSCL) paradigm (Koschmann, 1996). CSCL is based on a socio-cultural vision about cognition, and in these virtual learning environments the enrichment of interpersonal learning contexts is sought. From this perspective, learning is a social and distributed process in which both teachers and technology have a mediating role as cognitive and social facilitators (Salomon, 1992). Because of the potential these technologies

have to create virtual learning environments, our training proposal used ITC in a virtual classroom. In what follows, we describe the design of the proposal and discuss the results obtained from its implementation.

### **Description of the strategy**

The main objective of the course was to train teachers on an appropriate strategy that could be used to introduce the debate of biotechnology topics in class. The topic employed for the PBL lesson was transgenic plants, and the problem was designed to be solved through ICT-based distance learning. The technological resource used was Virtual Classroom on the Moodle platform (Module Object-Oriented Dynamic Learning Environment: <http://moodle.org/>).

The training activity was centered on the collaborative solution of an open problem (Figure 1). Course activities, mode of work, and resources used are listed in Table 1. First, after writing a pre-test, the teachers read documents and newspaper articles, which opened a spectrum of problems associated with GMOs. This reading together with a general discussion occurred in an open forum. After that, teachers (hereafter called «students») were divided by tutors in working teams (hereafter called «base teams») made up of four people, and they were presented a hypothetic problematic situation about growing transgenic plants. These tutors were two teachers from University (Universidad Nacional de Córdoba).

**Figure 1:** «Problem presented to students in order to be solved in teams»

To: "Consultancy Group"  
 From: Mr Mayor of the City  
 Subject: Possible Relationship between the Growth of Genetically Modified Organisms and the Birth of Children with Congenital Malformations.

In the last five years, several cases of children born with congenital malformations have been detected in our city. Citizens gathered information about the possible causes of these diseases and they concluded that congenital malformation could be due to Genetically Modified Organisms (GMOs) grown near the city. As a result of this inquiry, these citizens submitted a document in which they summarize the main findings of some reports to the local government. These reports explained that possibly farm workers and people living near farms could be breathing the pollen of transgenic plants. In this way, bacterial genes used to create transgenic plants would enter the human body. These genes would transform those people's cells and, apparently, they could be transmitted to future generations in a vertical way, which would cause malformations. The citizens attached a demand to this document for damage caused by not controlling this agricultural activity. They claimed that growing transgenic plants should be prohibited in the city and its surroundings. Because of the complexity of this issue, we would like to have an independent study on the subject, so that the available scientific evidence is clearly identified. We know that you are a group of capable consultants in this field and would like to ask you to determine the possible relationship between the growth of GMOs and the birth of children with congenital malformation, and to provide suitable solutions.

**Table 1:** «Course organization and resources used»

Activities	Mode of Work	Resources Used
Pre-test	Individually	Questionnaire
Analysis and discussion of newspaper articles	All the students	Open Forum
Presentation of the problem and role designation	Base teams	Private forum and Private wiki
Exploration of the problem (meta-analysis)	Base teams	Private forum and Private wiki
Analysis of new bibliographical sources	Base teams	Private forum and Private wiki
Discussion between peers	Discussion between members of different teams that share the same role	Forums organized for different roles
Discussion and proposal of possible solutions	Base teams	Private forum and Private wiki
Collaborative solution	Base teams	Private forum and Private wiki
Discussion of the solutions	All the students	Open forum
Elaboration of a didactic proposal	Individually	Task
Essay (meta-cognitive analysis)	Individually	Task
Post-test	Individually	Questionnaire

Each member of a base team had a different role; the teams first activity was to work on the designation of roles, considering that each role had a specific mission in the solution of the problem (Table 2). This activity took place in «private forums», to which only the members of the team and their corresponding tutors had access. After roles were assigned, students were invited to reconsider the problem through meta-analysis guided by the following questions:

What do I know about this problem?

What do I need to know to solve the problem?

How can I find the information I need?

What ideas come to mind to solve the problem?

**Table 2:** «Details of the missions assigned to each role»

Role as a member of "Consultancy Group"	Assigned work
Genetic Consultant	Determine whether or not pollen from transgenic plants can modify the DNA of people who may be in contact with it, and whether these mutations can be inherited or not.
Representative of an Agricultural Company	Provide information about the economic benefits and problems that growing transgenic plants has for the city and submit a proposal for an alternative way of growing plants.
Representative of the Local Medical Board	Provide information about the possible effects that growing GMOs may cause in human beings.
Representative of an Environmental Association	Provide information about the possible environmental effects caused by growing GMOs.

Once the case had been reconsidered, students carried out a bibliographic search with some sources they found useful and with other material available in a virtual library within the virtual classroom. Each team was given three articles, from which they had to make only one summary. This teamwork was guided by tutors, who monitored the presentation of their work. This summary had to be made in

a wiki and it was supposed to show how these articles contributed to solving the problem.

In the next stage, an «exchange between colleagues» was proposed: each member of the team participated in a specific forum outside their base team. These new «specialists» forums were made up of members who shared the same role. There were four such forums: a forum of genetic consultants, a forum of representatives of agricultural companies, a forum of representatives of the Local Medical Board, and a forum of representatives of environmental associations. Information, questions and problems -among other issues- were shared to enrich the contributions that each student would make when they came back to their base team. Next, possible solutions for the problem were discussed and evaluated in base teams. In order to evaluate the solutions provided, the students developed a number of criteria which were then applied until they reached a solution that was agreed by every member of the team. These proposals were shared with the other groups in «open forums». Finally, each student made a didactic proposal for their classrooms and they wrote a final essay requiring them to reflect on what they had learned and how they achieved this learning. These individual activities were designed to make students think about their learning process and to apply the acquired knowledge. A posttest was also administered to all students.

## **Evaluation**

Seventy-five secondary school Biology and Chemistry Teachers participated in the course, coming from different regions of Argentina and Uruguay. Tutors obtained



information about the students' progress by accessing the forums. In addition to this, these forums allowed tutors to monitor students' participation, to encourage those students who did not make much contribution and to foster the analysis of the messages in order to identify relationships, agreements and disagreements. The elaboration of wikis combined with forums as discussion sites allowed tutors to monitor each team's construction process. Students' individual learning was evaluated through a pre-test, a post-test, the elaboration of a didactic proposal, and a final essay about meta-cognitive analysis.

After discussing between them and reaching agreement on the selection of roles and their commitment to their team, students in each team approached the problem from their personal perspective. Consequently, the problem acquired special importance to each one of them, and real and positive interdependence conditions were created to work on solving the problem. However, this strategy with clearly defined roles for students posed the challenge of dealing with the absence of a member in a team. As it is well-known, the dropout rate in distance learning is always high, and this experience was no exception. Even though more than 60% of the teams continued intact until the end of the course, tutors decided to join students from those teams in which one or more members were missing. They introduced the members of pairs of reduced teams to each other and referred to the roles that each member had chosen. Remaining members were thus invited to become a part of a new team in order to continue the work. In some cases, integration was

fast and successful, so a new team was made up. In other cases, the integration process required that the members of a joined team reconsider their objectives and retell the processes they had gone through as well as the decisions they had made until that moment. This reconsideration involved thinking again about the individual activities carried out according to their roles so that the students can make up a new team. Finally, in other cases, integration caused tension; consequently, cohesion between the members of the team was not established, so these students worked in an individual and non-collaborative way.

Moderation of forum conversations was another challenge that this strategy posed to tutors. Because some of the students were used to «pasting complete texts» extracted from web-pages (instead of elaborating their own argumentation supported by the articles read), tutors mediated communication to encourage argumentative interaction and personal production, and to avoid plagiarism. In the same way, bibliographical sources were an issue for students. Even though students used articles taken from a «virtual library», in some cases they were not used to applying a critical attitude while carrying out a bibliographical search. It is important to emphasize that this critical attitude was encouraged by tutors from the beginning of the training course. The activity tutors assigned in order to achieve this was called «Analysis of New Bibliographical Sources». From the comments that students posted, we could conclude that this participation in the forums with members that shared the same role was an interesting positive experience for them. As far as interactions are concerned, they were interpreted according to the interactional

analysis model for examining the social construction of knowledge (Gunawardena and Anderson, 1997). The most frequent types of interactions found in these forums were sharing/comparing information and negotiation of meaning/co-construction of knowledge. After that, when the students came back to their «base teams», in which they presented their ideas and provided their argumentations, it was clearly depicted that knowledge had been socially constructed.

### **Final Reflections**

When analyzing the results obtained during this training activity, we found that a collaborative teamwork carried out by members with different roles led to the solution of a biotechnological problem. The students' interventions were mediated so as to help them understand, reflect and draw inferences. Tolerance, respect towards teammates' ideas and the defense of their own points of view with solid arguments were encouraged. Regarding students' ideas presented in their essays, we believe that this training allowed them to reflect on their classroom practices when approaching socio-scientific problems. Therefore, this training fostered the spread of new teaching perspectives and created interdisciplinary work nets and contacts with other teachers. All this allowed the discussion and exchange of instructional tools and best practices between teachers. We expect to be able to repeat this training with other teachers, as well as to deepen the analysis of forum interactions in the future, as it would be interesting to explore what type of interactions

occur in the collaborative solution of a socio-scientific problem.-

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