

ICT to Train Students towards Creative Thinking

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Abstract

This study examines the role played by Information Communication Technologies as cognitive tools in the classroom. We refer to the theoretical context considering creativity not only as the skill of fantasy and imagination but also as an educational process.

In particular, in the experiences described, we highlight how creative thinking can be stimulated through the use of ICT integrated into the curricular activities. The methodology carried out during the three years of the project is based on *scaffolding* and leads students to increase their diverging thinking through increasingly complex activities of creative writing, use of multimedia systems and online resources, and finally the design and development of a hypertext.

Keywords

Creativity, Multimedia, Educational methodology, ICT and curriculum

Research framework

With regard to 'creativity' literature there are a lot of theoretical perspectives of which the most significant are the gestaltist, psychoanalytic and humanistic ones. These theories, summarised in Mencarelli (1972), besides focusing on the relationship between the concept of intelligence and creative thinking and convergent and divergent production, are interesting because they see creativity as part of a wider view that also considers the educational aspects involved. In this sense, creativity has to be considered not only as the skill of fantasy and imagination but also as an educational process that trains teachers to re-evaluate the *processes* and to appreciate different ways of thinking, social links within the classroom, and language aimed at comparing and integrating different points of view (Guilford, 1958; Dewey, 1991, Bruner, 1993).

This perspective is considered even more important because the didactic research can be concretely connected with the multimedia dimension promoting the use of strategies to transfer and construct knowledge that help to develop the student's creative potential. In fact, thanks to the introduction of ICT in didactics, the school has interpreted the traditional task of cultural literacy in a more original and up-to-date way, redefining strategies and methods of the complex teaching/learning process.

A didactic aimed to train students towards creative thinking has embraced some significant changes that, as Cosentino (1999) highlights, do not concern only the contents but more especially the procedures; in fact what is really necessary is that school subjects are used in a different way as well as being selected and classified. In other words, the particular thinking processes involved in each discipline must be revalued in the light of a didactic aimed at developing creative thinking. This means abandoning the idea of linearity in the teaching/learning processes and increasing the value of holism and contextualization. It means opening all the learning doors (different languages, different style of thinking, etc.) in a multimedia environment effectively based on dialog and cooperation. The concept of effective study is analyzed thoroughly in previous version of this paper; in fact, this is an extended and modified version of our paper presented at the First International Workshop "Developing Creativity and Large Mental Outlook in the Computer Age" (Allegra, Chifari & Ottaviano, 2000).

Learning environments using the computer as a cognitive tool have allowed us to reach this aim. In fact, the research shows that the predisposition of environments that envisage learning supported by multimedia and telematic technologies can stimulate students to improve the divergent production that, as Guilford mentioned

(1958), is the skill of finding more than one solution for the same problem, imagining, discovering and inventing.

Description of the Project

The project has been carried out with the collaboration of a secondary school. The aim is to test and evaluate multimedia and telematic technology as a medium to support new teaching and learning processes, focusing on the definition of suitable methodologies for its integration in the curricula.

In carrying out the project we have activated an experimental course, lasting three years, in which all the teachers are involved in defining paths for the integration of ICT in all the subjects. Before starting with classroom activities, researchers trained teachers in technological and methodological aspects about the educational use of ICT; during the first year, the teachers had difficulties adapting to the new way of working, but after the first results and with a growing awareness of the potentialities of the new media, their contribution in defining new learning paths was increasingly significant. Besides, the disadvantaged environment of this school is one of the elements that characterize this research. In fact, it examines the role played by ICT in the improvement of higher thinking skills such as diverging thinking, by re-motivating pupils and adapting teaching methods to students' individual needs (Jonassen, 1994).

The didactic activities were defined by teachers and researchers to help students to express themselves, increase their perception, explore situations, compare their ideas and develop their imagination, and allow them to reveal their thoughts and feeling; to this aim the assignments were individualized and enabled the students to express their creative potential. In particular, the creative writing activities used in developing stories and analysing, searching for and organizing information during the hypermedia production have proved useful in stimulating divergent thinking, activating several ways of learning: playing, communicating and cooperating, deciding, comparing and accepting ideas of the other pupils, etc..

The activities of the first year regarded mainly computer literacy both for teachers and students by the use of simple applications for the management of texts and images. During the second year, we guided students in the use of educational CD-ROMs and web sites, with the aim of facilitating the acquisition of mastery in searching for, acquiring and processing information. To this aim teachers and researchers focused on the definition of effective didactic models, starting from the analysis of multimedia resources chosen for the curricular activities. The third year was focused on the implementation of a hypertext, leading students to acquire various critical design skills and to cooperate together to pursue a common aim thus developing social skills.

Methodology

To make the learning process more effective and to facilitate the design of sub-goals and formative evaluation we have divided the experimentation into a series of micro-activities (MA). All the micro-activities are aimed at leading students towards the acquisition of an effective method of study by an integrated use of different technologies. More in detail, all the activities (writing, navigation through hypermedia, construction) and the relative assignments were supported by tasks elaborated *ad hoc* by teachers and researchers for the students, differentiated on the base of their socio-cultural level and study motivation. The assignments served as a procedural guide, helping students to approach the task better, choosing the relevant information and solving the problem of inattention.

By structuring the learning path in micro-activities, through a succession of increasingly complex phases, teachers integrated ICT effectively in the curricular activities. The organization of each micro-activity was different from the others in its content and the task to be carried out, but based on a common structure, which is synthesized below:

1. subdivision of the pupils into heterogeneous pairs and assignment of roles;
2. choice and preparation of didactic material and of resources for each group which differed from each other but were complementary with respect to their overall goal;
3. preparation of an instruction sheet regarding the activities to be undertaken broken down into steps to assign to the pupils at the beginning of each micro-activity;
4. preparation of an evaluation sheet (pre-test) concerning the topics previously studied in class which to be developed with the use of ICT; the administration of this sheet is useful in understanding the added value of ICT in learning;

5. research phase which includes finding, extracting and elaborating the information;
6. phase of socialisation of the information with classmates;
7. preparation of an evaluation sheet (post test) and its administration;
8. integration of the new material produced into hypertext.

Let us now consider an example of how one of the micro-activities was structured.

Example: The objective was to guide students in the search for useful information enabling them to acquire practical knowledge of the city of London. They were all given the same CD-ROM about London but with different and complementary assignments. Each pair, according to their assignment and in an allotted time, began the research by obtaining the information from the CD, following extremely personalized pathways of greater or lesser complexity with regard to their conceptual organization. Thus some pupils restricted themselves to providing answers, the minimum objective set in the micro-activity (e.g.: the main information about churches and buildings). Other students added further details to the information requested (e.g.: architectural styles) by browsing through the Net. In this way they activated highly structured learning pathways. Once all the information had been obtained, the groups presented their results using oral summaries and sharing the multimedia files they had produced. At the end of the micro-activity, divided into several units, each pair of students produced a mini hypertext itinerary about the city of London, taking into consideration topics which changed in each unit.

Sample

The sample consisted of 14 students at an Italian secondary school, followed over the three years of the course. The students' ages range between 11 and 14 years, thanks to the longitudinal nature of the research. The socio-cultural level of the students was considered to be deprived due to the lack of basic skills and of intrinsic study motivation.

Tools

To monitor the different activities, specific tools have been developed. In particular for the computer literacy phase of students a guide has been designed for acquiring the main functions of interaction with the computer and to manage simple data (copying/cutting pieces of text, making tables, formatting text, etc). This guide gave students procedural inputs and required the filling in of fields concerning the acquired modalities of use; in this way, using his own words to describe how to perform certain operations, each student constructed his own user guide, leading him to reflect on his learning path.

Another tool designed for the monitoring was a semi-structured observation check list, subdivided into two sections: the first one to identify the social dynamics and aspects such as the level of participation, cooperation, competition and motivation. In this section the observers (usually teachers and researchers) had to write when, with whom, and why pupils interacted among themselves or with teacher; or what kind of problems they met and how they solved them, how and what rules the pair established. The second one regarding the cognitive strategies adopted to face different tasks based on the use of CDs and on-line resources.

Finally, questionnaires have been developed to stimulate the meta-cognitive awareness of acquired knowledge, both for the mental operations and for technical procedures adopted to solve problems. Students had to explain the reasons of their actions, motivating their choices about the paths followed, analyzing the semantic structure of the multimedia system used or developed. It has been emphasized that the construction of the hypertext was a very important test for evaluation and self-evaluation.

The three steps of the experimentation: computer literacy, fruition and construction

The first year of experimentation concerned computer literacy carried out using teaching strategies to establish basic skills and to achieve cognitive aims. Specifically, a learning path was planned to write short stories containing texts and illustrations allowing the teacher to reach the important goal of assimilating the students' syntactic knowledge. The activity stimulated the mingling of skills, competencies and semantic-literary and technical knowledge and also the creative contribution (Cohen, 1996).

In particular, the activity named "*From the grapheme to the ... story*" was aimed to promote the knowledge and the use of grammar rules in written work; to promote the meta-linguistic reflection by reviewing the text in a recursive way, indeed, to develop creative thought. Each pupil had to invent a story with the features of a fairy-tale or a short story starting from a key word in order to produce a dictionary of stories in alphabetical order. During the sessions of work, each pair of students using their imagination and the potentiality of word processor, taking turns to write at the keyboard so that "the two components" were continually working and discussing the task together.

Considering their lack of basic skills for effective communication, in order for the students to express themselves clearly to a hypothetical reader they needed to learn the grammar rules. With their newly acquired command of the language the students were able to construct the story to type on the computer, using their imagination. In the process of writing, developing and correcting their work the students also became familiar with the use of computer. At the end of a series of reviews both of the graphic presentation and correct use of grammar rules, original drawings concerning the story were added to the text. The drawings were not just to make the text more attractive but enabled the students to learn how to use the scanner, the colour, the shape and the techniques needed for illustrating a story.

The second year of experimentation aimed to enable students to acquire and elaborate strategies for using CD-ROMs for study purposes. Following the methodological construct, described above, during this phase we have assigned to students, subdivided in heterogeneous pairs, specific tasks based on the search and extraction of information from CD-ROMs (encyclopaedic and educational) and online resources in order to integrate it with the topics studied in the classroom. Besides, it was important that students learned to reflect on the hypertext structure (nodes and links) with the aim of successfully changing their role from *reader* to *author*.

In particular, the teaching/learning path was based on assignments that had different levels of difficulty: structured, semi-structured and free; these were administered not in a rigid order but in response to the feedback received during the session of work. In the structured assignments each pupil was instructed to follow a precise learning path so as to focus his attention on specific aspects of the CD-ROM. Then each group had to answer a series of questions (semi-structured assignment) which differed in quality and quantity according to the potential of the group. This strategy gave students more freedom to surf although they still had to consult certain parts of the CD in order to answer the set questions.

In this way the questions had two objectives: to guide the students through the information; to check whether the subject had been understood and learnt. Afterwards, the students were engaged in sessions of work based on free assignments; each group was totally free to explore the given resources to create a text (including in it also images) which examined all the studied topics. It was in this phase that the students could express themselves freely; in fact their final products were the result of precise choices and successive changes concerning the layout of the text and of the organisation of contents and images. This work when revised represented the information units to be linked together during the hypertext design phase. It's important to emphasise that each group had to answer a number of questions before beginning the activities in order to establish their existing knowledge of the assigned subjects. The aim was to assess the increase in knowledge after using different media (Kenny, Desjardins, & McDonalds, 1997).

The aim of the third year of activity has been to improve students' socio-cognitive skills utilising the "learner-as-designer" environment by the assignment of different study tasks to each group whereby they research and collect the information useful for the co-operative construction of the hypertext (Miu, & Rutledge, 1997). To pursue this aim we have subdivided the work sessions into phases: planning, design, production and co-operative evaluation of pieces of the hypertext.

During the planning phase, students were engaged in brainstorming sessions on: what to create (the content); who to create it for (the audience) and how to develop the program (the process). Moreover, students were invited to think about the previous knowledge obtained in the period of fruition, in fact, during the second year students had acquired the concept of hypertext.

During the design phase, students were engaged in storyboarding sessions to: guide them in the mapping of information units (nodes and links); monitor their own work; help to communicate their ideas with the other groups and teachers. Furthermore, in this phase students took turns to do the various tasks: some drew pictures, some scanned the photographs, others wrote the texts, and still others made the links. Students shared ideas and helped each other with programming; although competition existed between pairs of students they competed in a positive way, understanding the importance of collaboration in a team.

The production phase was divided into two important activities: the research process and the hypertext development. The research process was carried out assigning to each team different tasks to collect information about the topics that they had studied. To pursue this aim, they used lessons, books, CD-ROMs and online resources to search for the relevant information and then write it on the computers. The units produced were developed according to personal graphic styles. Regarding the activity aimed at developing the hypertext, on the base of their own research each team produced multimedia information units which they set out to accomplish using hypertext tools. In the end all the multimedia units were collected on the hypertext with a common interface for the main nodes and with links produced creatively and cooperatively by each group.

During the process of hypertext construction students were engaged in sessions of formative evaluation and revision in which they discussed and shared opinions on the accuracy of the information and the connections and on the attractiveness of the interface. Working in this environment helped students to see the importance of each role and to understand that the success of a project depended on team work.

Final considerations

The activities based on word-processing have accustomed the students to: think about the general structure of a text; carry out structural reviews, inform other people about their ideas; create pleasing and attractive presentations; exchange pieces of work; read together and comment on a text written by an individual student or a group.

At the end of the first year, 70% of students reached a good mastery of the PC. In the specific context of the research, the video writing played an innovative and productive role, especially, regarding meta-linguistic reflection and the aspects of linguistic education which benefit from this, that is reading, writing, speaking and listening. Using the word processor we can obtain several draft versions of stories: making changes to improve the creative aspect of the text organization and revising grammatical and syntactic forms. The spelling corrector played an important role enabling the student to minimize the frequency of unsightly corrections and the fear of making mistakes; these factors are often a obstacle for subjects with spelling difficulties. In this way the text may be treated as a malleable substance: students could transpose paragraphs, insert new words or their own drawings, make deletions or corrections while having a clean text, print various copies so that the product could circulate more easily.

The observations on the fruition revealed that this class benefited from the gradual progression of the teaching/learning process; the students were stimulated to bear in mind the didactic aim, subdivided into its various phases and made clear by the assignments. In this way attention and concentration times benefited.

The time dedicated to each activity (pre-test, information search, elaboration and synthesis, study of material and post-test) permitted the students to acquire the skill of managing the time and their own resources. All these activities have also stimulated technical and creative skills: definition/discovery of problems; search for and construction of diverging solutions; collaboration and exchange; fantasy and imagination.

During the period of fruition we have observed that using the CD-ROM the students were stimulated to adopt research strategies and to develop:

- basic skills (logical, expressive, linguistic);
- decision making skills about their learning path;
- social skills;
- the skill to: face various tasks and paths at the same time; remember the links they have consulted; re-create a cognitive map of the information.
- the creative approach to solving a lot of technical and pragmatic aspects.

For students, creating a hypertext containing their own ideas and the subjects studied has been very important. They have perceived that hypertext design has provided a way for them to be creative and express themselves, developing a strong sense of pride in what they have created.

In order to produce the hypertext, the skills required include analysis of material, discrimination of relevant contents, production of a summary, review of material and identification of links with the material produced by others, implementation and assembly of material produced and collaborative work. Other important aspects concern the sharing of information and cooperation with other classmates, the creation of a prototype and evaluation of its performance, reflection on the created product and on the activities carried out.

According to the proposed methodology, by giving the pupils the chance to write, organise and present information, communicate with others and explore, they acquire different skills, including communicative, pragmatic, linguistic, textual and meta-cognitive skills. More in detail, it was observed that, from the first year of school until the end of the third year, the development of "meta" skills:

- *meta-cognitive*;
- *meta-communicative*;
- *meta-semantic*.

We have argued that the hypertext production exemplifies team work more than individual effort, stimulating the development of complex project skills: learning how to organize, and how to tackle and complete a project; of multi perspective reflection: comparing comments, evaluating a problem from different points of view.

Future perspective

The experience described has highlighted the importance of establishing formative spaces that have a positive affect on attitudes, the different ways of acquiring knowledge and the students' cognitive and behavioural development. The design of the research process articulated in brief sessions of work has allowed teachers to stimulate students in the acquisition of divergent thinking. This isn't a gift we are born with, in fact, the achievement of *insight* is the result of a process that involves didactic procedures that allow each student to develop his own individuality.

More in detail, the methodology adopted during the three years of school, the experiences based on the use of different media and the redefining of the traditional strategies to teach and learn have been important factors for the effective development of creative thinking: students have improved their way of dealing with unusual situations and their critical sense and have found new, original and more complex connections between the concepts.

The direct observation of students' behaviour has been useful not only for the recording of the most important phases of the experimentation but it has also permitted us, as a future perspective, to systematise the complex interplay of the variables involved during the research and *in-formative* path.

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