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Progress to work

Contesti, processi educativi e mediazioni tecnologiche

EXTENDED ABSTRACTS DELLA MULTICONFERENZA EMEM ITALIA 2017

Bolzano, 30-31 agosto, 1 settembre 2017

a cura di
MARINA RUI

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03

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Developing Problem Solving competences with CLIL methodology through innovative technologies

Alice BARANA[1], Marina MARCHISIO[1]

1 Department of Mathematics of the University of Turin, Torino (TO)

Abstract

Communication and problem solving are two crucial skills that the school system should foster to the purpose of education, in order to prepare students to join the contemporary world of work. To this purpose, the Department of Mathematics of the University of Turin has developed a model for problem solving activities with CLIL methodologies. This paper shows and discusses the details of the model: it consists of group working on real-world problem solving, using the new technologies for both the solving process and distance communication. A vehicular language must be used during the whole process, which should be presented in written form with deep argumentation. This methodology is analyzed under a sociocultural perspective and it is validated by theories on language learning and problem solving.

The discussion on the model is conducted through the results of a teacher training experience on the preparation and management of activities with the methodologies proposed: teachers acknowledged their usefulness as for the development of competences for students' future career, and they detected the problems in the realization of similar experiences, mainly tied to the difficulties in changing teaching methodologies.

Keywords

CLIL, Collaborative Learning, Foreign Languages, Problem Solving, Virtual Learning Environment

Introduction

It is more and more common, in companies turning into the Industry 4.0 model as well as in other kinds of organizations, to observe situations where groups work together collaborating from different countries through the use of technologies. If the perception of distance can be reduced by the computer, employees are supposed to be able to discuss and share solutions in a vehicular language; the communication between workers with different cultures, languages and backgrounds is pointed out as a major difficulty in computer based collaborative working (Bjòrn et al. , 2014). In order to prepare students to this new working perspective, communication and problem solving (PS) skills should be fostered as aims of secondary education.

The Content and Language Integrated Learning (CLIL) methodology has been proposed to fulfill just this purpose: besides increasing disciplinary and linguistic competences, it is conceived to educate students to be citizens of the world and to prepare them to get better job opportunities in an international society (Gabillon and Ailincai, 2013). Italy is one of the few European countries where CLIL is provided for by the educational system: all students attending the last year of upper secondary school have to learn one non-language subject through a foreign language (Commission/EACEA/Eurydice, 2017). To make it possible to carry out meaningful CLIL activities, an appropriate teacher training is needed.

The Department of Mathematics of the University of Turin has proposed an innovative model for developing group PS activities with CLIL methodology using innovative technologies, and it has trained some teachers of different subjects to an effective design of similar activities. In the following paragraphs the model of such activities is presented and discussed under a sociocultural perspective, the methodologies and the results of the teacher training actions are shown and some conclusions on the key strengths and set of problems are drawn.

State of the art

According to modern theories on problem solving, language is one of the media through which modeling and thinking are conveyed: it has a key role in group discussions, in the presentation of data and solutions (Lesh and Leher, 2009). It is supposed to be a tool for thinking, not just the format we think in. Recent linguistic theories claim that language acquisition takes place when a learner focuses on the production of comprehensible and meaningful input for the addressee, and the interactive negotiation of meaning promotes modifications of the output and raises awareness of the meaning-carrying potential of linguistic structure. Thus, a teaching approach focused on meaning and language should be more effective than one that focuses on the structural aspects

of the target language (Heine, 2010). This approach legitimizes the integration of content and language in PS activities, where students have to understand the problematic situation, to discuss, both in spoken and written form, about the modelization and to produce a clear and comprehensible solution.

Activities of this kind fit sociocultural models, mainly because sociocultural theories see language as the primary tool mediating the construction of knowledge, and because of the fundamental role recognized to social interaction in learning (Moate, 2010). In particular, activity theory (AT) offers a suitable theoretical framework for analyzing CLIL problem solving activities, as it focuses neither on language nor on content, but rather on the interaction of the two considered as an instrument to fulfill the learning outcomes (Paretti, 2013). According to AT, the learning outcomes are the results of the action done by at least two activity systems, the smallest units of analysis, represented in Figure 1. When the interactions between the elements face some contradictions, the systems modify themselves through expansion and this provides learning. For this reason, AT is a powerful tool to analyze both learning and working activities (Engeström, 2009).

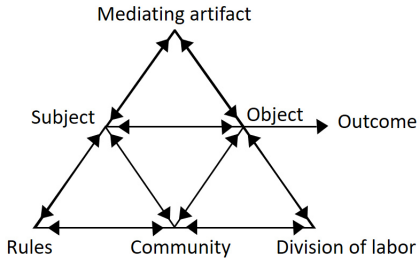

Figure 1 – One activity system, the unit of analysis of action in activity theory.

Methodology

In this theoretical framework and social setting, the Department of Mathematics of the University of Turin has developed a learning model for CLIL problem solving activities. The model concerns a real-world problematic situation, challenging for the students and meaningful for the underlying disciplinary content. Students are asked to solve the problem in small groups of three or four people, discussing in a vehicular language (usually English), and to write down the solution, commenting and justifying data, solving steps and results. The disciplinary content is discussed after the solution, through the generalization of the solving process or the individuation of the key points.

During the resolution, the aid of technologies is recommended. For instance, for solving Mathematical or scientific problems, we propose to use an Advanced Computing Environment (ACE): a system capable of performing numeric and symbolic computation, interactive geometrical visualizations in 2D and 3D, embedding of interactive components where students can change the parameters and explore the varying situation, automatizing computations through algorithms and procedures. An ACE empowers PS in that it offers several possibilities for representation - fundamental in the PS process – and it frees users from manual computations, allowing them to focus on strategy. Moreover, text and representations can be inserted in the same worksheet in an elegant way and exported in various formats; hence, it is a complete environment which can host the whole PS process (Barana et al., 2017b).

Relevant PS often requires more than one hour to be concluded. The model provides that the group work is finished at home through a Virtual Learning Environment (VLE). There, teachers can add interactive materials related to the lesson, chats or forums for going on with the discussion, wiki for the collaborative writing, tools for the submission of the assignments, tools for the self-assessment, questionnaires to monitor students' expectations, difficulties and appreciation.

The model described above can be represented with several activity systems where the instruments are, in turn, language, discipline and ICTs, as shown in Figure 2. The student is the subject and the problematic situation is the object; the action of solving the problem, conducted by groups of students with intrinsic and extrinsic rules, has as outcome the resolution, through which disciplinary, communication and PS competences are developed.

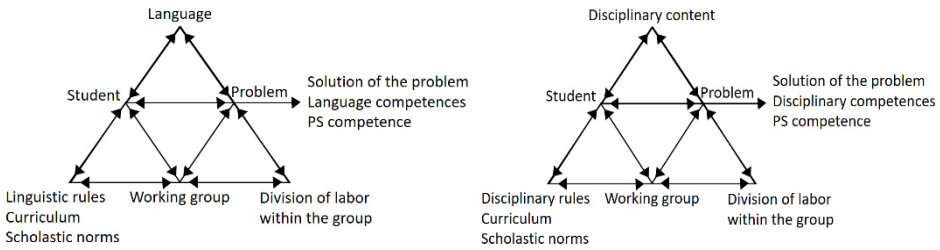

Figure 2 – Two activity systems that intervene in the activities of CLIL Problem Solving.

This model can be applied to every (non-linguistic) subject and even to multidisciplinary problems, which would be more realistic. Multidisciplinarity would be coherent with the CLIL philosophy, which promotes the integrated learning of different subjects to prepare students to real-world and working situations.

The activity of PS can successfully fulfill disciplinary and transversal aims. Disciplinary content is mastered: it must be recognized as a tool for solving the problem and its understanding is improved after it has been used in a real situation. Critical thinking is put into practice through the choice of the strategy and the interpretation of results, as well as through the entire solving discussion. All forms of linguistic competences are put into play: written comprehension in the task of understanding; written production in the expression of the solution; oral comprehension and production during interaction with classmates.

The problems context plays a key role: its interestingness increases engagement and motivation; the practical application of theoretical contents helps student understand them better.

Learning how to use an ACE, or other advanced programs, is useful for students' career: it is highly likely that they will have to master a specialized software for their work. Moreover, the possibility of interaction in the VLE is similar to many frequent situations of computer based collaborative working. Both these environments can be set in English (or another language) so that students can be even more immersed in a target language environment and acquire technical vocabulary in a true learning-by-doing way.

The assessment of these activities should be carried out considering the whole action of problem solving conducted by the interaction of all the elements of the activity systems: the understanding of the problematic situation, the strategy chosen, the solving process, the argumentations provided, the group collaboration, the linguistic expression. A rubric with these features as indicators could be effective to the purpose.

Results and discussion

This model has been proposed to 35 secondary school teachers attending a CLIL course in Spring 2016. The activities were organized according to the model of teacher training developed by the Department (see Barana et al., 2017c), based on the ideas of using the same methodologies that teachers are supposed to learn, swapping the roles (teacher-student) to support the shift to a student-centered approach, building a community of practice which could share experiences and materials. The training program included:

- two meetings in presence, one on problem solving (teachers were asked to solve a problem in groups in a vehicular language) and one on problem posing (teachers were asked to propose new problems working in groups);
- the creation of an online community of practice in a VLE (an integrated Moodle platform), through which teachers were asked to share the problems elaborated;
- online synchronous meetings in the VLE through web-conference about how to use the platform from the teacher's point of view, so that they were

able to adopt this VLE with their students.

The teachers who attended the training were experts in the most disparate subjects: from Mathematic to Social Science, from Biology to History of Art and many others. The activities in presence were conducted in groups and in a vehicular language (English), to foster teachers' awareness of the difficulties that students can face, to make them become more confident with the language, and to facilitate collaboration between teachers of different subjects, who too often work separately. At the end of the training, the teachers were asked to fill a questionnaire where they could express key strengths and criticisms of these methodologies.

Results were decisively satisfying: Figure 3 shows the average values, in a 1 through 5 scale, that the 25 teachers who answered the questionnaire assigned to the effectiveness of group problem solving in a foreign language for developing language, disciplinary and cross-cutting skills. All the questions registered at least 90% of positive answers (3 or more). In particular, teachers recognized the validity of this methodologies for providing students with employability skills and preparing them to be competitive in their future job.

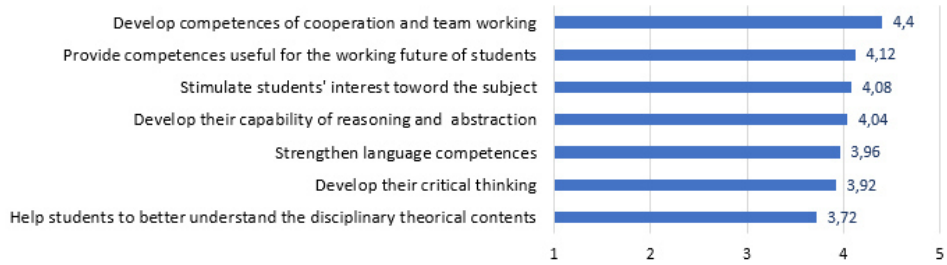

Figure 3 – Reasons for which the methodology is effective, according to teachers.

From open answers, included those in the questionnaire, it emerged that the main obstacle that teachers think that students would face is the use of a foreign language in real-world situations (pointed out by 76% of teachers). About 30% hold that students will have difficulties in using critical thinking, as they are accustomed to repeat knowledge, not to put it into practice. Also group working is not a simple matter according to 25% of teachers. Other problems pointed out by a minority of teachers are: the lack of concentration needed to complete the work, the scarce acceptance of the difficulties due to an unusual way of learning, the low interest for the subject. The main difficulties that emerged clearly show that Italian school is still bounded to a transmissive model, and that sometimes teachers are the first ones to be afraid of changing methods. The methodologies here proposed should just help develop those skills that the school too often ignores although being so useful to students for their future.

What teachers think their difficulties are reflect the last considerations: 40% of them think they do not know the language well enough, 12% have difficulties in changing their teaching methodologies and 20% acknowledge that the preparation of effective activities requires time that they don't have. Others also fear that the hard work would not be compensated by success with students, others again have difficulties in considering students as groups instead of as individuals or in managing group activities, or even in finding interesting and meaningful problems to propose.

Although highlighting possible and realistic problems, almost all teachers are aware that the realization of the activity itself is a prompt to overcome difficulties, the frequent proposal of PS activities and the use of a foreign language in natural situations can be effective to develop the critical thinking skills and the language confidence that students are lacking. Moreover, teachers were also satisfied with the training course: in the final questionnaire they stated to have appreciated the activity in groups (average: 4.4, st. dev.: 0.7), working with colleagues of other disciplines (average: 4.4, st. dev.: 0.7) and conducting the activities in a foreign language (average: 4.5, st.dev.: 0.6). All teachers answered positively to these questions, more than half answered with the highest value (5 out of 5).

Conclusions

The experience of teacher training presented shows that CLIL activities of real-world problem solving using the new technologies discussed above is effective to promote disciplinary and communication competences, and especially cross-cutting skills, such as group working, computer based collaboration and critical thinking, which are more and more necessary to join the contemporary working panorama.

The main obstacle that the implementation of this kind of activities will meet seems to be the shift of methodology, which could destabilize both teachers and students, though in Italy innovation in teaching and learning has been recommended by institutional provisions and laws since 2010. The commitment of carrying out at least one didactic module in a foreign language during the last year of upper secondary school is a clear prompt for changing things. In this moment, teacher training and support is decisive to share and spread good practices.

Since 2012 the Department of Mathematics of the University of Turin has been committed in the diffusion of PS methodologies for learning Mathematics and scientific disciplines through teacher training, classroom experiences and projects at local, national and European level, and it firmly believes that this path will help build a more responsible future society (Brancaccio et al., 2015) (Barana et al., 2017a).

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Marina Rui, ricercatrice in Chimica Teorica all'Università di Genova, attualmente è Delegato del Rettore per l'e-learning e per la rete EDUOPEN.
É il presidente in carica di EMEMITALIA (www.ememitalia.org).
È anche membro del Program Committee del Convegno internazionale sull'e-learning (IADIS e-learning) dal 2009. In qualità di chimico fi sico, è parte del ECTN (European Chemistry Thematic Network) dal 1997.

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