

## **CABRI 3D - the instrument to make the didactic approach more efficient**

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**ABSTRACT:** The paper presents general information about the CABRI géométrie applications designed by the "Centre National de la Recherche Scientifique" - "Joseph Fourier" University, from Grenoble. The last version of the CABRI 3D software has revolutionized in many educational systems the teaching – learning – evaluation process of the Euclidean Geometry in the tridimensional space. For the stimulation of the Mathematic teachers' interest in the use of this software, the paper shows the application's possibilities to explore dynamically and interactively the study of the Geometry, possibilities offered both to teachers and students. As well, for the same purpose, there are presented the advantages brought by the use of the CABRI 3D application in the teaching design, in comparison to the traditional didactic approach. There have not been omitted the digital opportunities offered by the software in what regards the achievement of the geometrical constructions, a determining step in facilitating the understanding and acquiring the solving techniques, and that, at the same time leads to the growth in the quality of the learning results.

*Motto*

*<<there is an opinion in which virtue the teacher is considered to be a transmitter of knowledge, but a teacher that respects himself must be "an explorer" of this knowledge and of the methods to transmit them.>>*

**Jean Piaget.**



## Introduction

In the contemporary society the dynamism of the changes in all the domains of the social, cultural and economic life is one of the dominant constants. These transformations of the society represent solicitations and challenges the school has to deal with, both through the way in which it organizes the knowledge and the learning, through the quality of the results in the end, and also through the ways in which it distributes them in the society. The answer found by the school to these requirements was to change the education's priorities, namely: to pass from knowledge as an assembly of information and data, to knowledge as a set of skills, 'to know to do, to know to act'. This step from transmitting and memorizing information to informing determined the essential shift of stress on the attitudes – aptitudes – knowledge triad, and implicitly the development of the skills and competences built through an experiential and practical learning.

The amazing progress of the TIC domain, the improvement and the extension of its applicability in all the other domains of the society in which we live have also led to changes in what concerns the purposes, the objectives and the strategies regarding the process of formation and education. The use of computers in schools and of the educational software in the process of teaching – learning – evaluation has represented and continues to represent the solution offered by the education to the society's progress. It is certain that the computers tend to become instruments used worldwide and Informatics a second maternal language, which makes the formation of digital skills to be a necessity of the educational process in any country worldwide. This necessity imposes another one, namely the

development among the teachers of another way of thinking and motivation to adopt an open attitude regarding the introduction of the computer use in the process of teaching.

Being aware of the "unlimited horizon of learning" offered by the TIC instruments makes the use of the computer to represent not only the symbol of modernity in the process of education, but also an effect that must be imposed without the possibility of rejecting it. The process of accepting and of introducing the computers in the teaching activity must be continued through permanent experimentation. The purpose of its everyday use must aim the students' performance level and the obtaining of the skills to use it effectively at the teachers' level, so that the formation and the education to be converted into a life success.

The introduction of the TIC instruments in all the educational areas, not only in the Informatics classes, has imposed important changes in what regards: the establishment of the objectives, of the design strategies and approaches of the learning process in general, and implicitly, the process of learning Mathematics in particular. These changes will bring high quality results if the teacher has the availability to quit the routine, to acquire the skills to use the computer in the teaching process, to assume the part of learning coordinator, and equally, the responsibilities given by this part. The growth of the results' quality will also be stimulated if: the students' acquired knowledge will not be appreciated only as the teacher's direct influence, but also as the result of the personal interactions with the textbooks' content, the TIC facilities and the collaboration with the teacher.

The continuous changes in our educational system, with its qualities and flaws, has brought real positive changes in the process of the informatization in schools: the computers connected to the INTERNET through the SEI program that have been given to the schools, through the elaboration and the implementation of AEL platform, the creation and editing of the educational software by the specialists from firms like SIVECO, INTUITEX, EDUSOFT, etc. Still, with all these things, through a simple Internet search command we can prove a significant difference between the elaboration and especially the use of the educational software in our educational system and the one from other countries. At the same time it is known the reality that the Romanian school system is, regrettably, conservatory and that the teachers' training in the computerized teaching and the use of the computers in the educational system are only at an experimental stage. The improvement of this situation imposes the promotion and the supporting of all the initiatives that have as object the

study, the research, the exchange of new practical experiences in the domain of the new TIC Pedagogic, which have as central objective the involvement of the student as an active and creative participant in the process of learning.

A happy context has offered us the chance to collaborate in an initiation activity regarding the use of the CABRI 3D software, with participant colleague teachers at the “*Université d’été*” organized at Sibiu in August 2008 by the French Embassy of Romania. There have been multiple benefits of this collaboration: general information about the development of the French educational software market for Mathematics, the French teachers’ preoccupation regarding the use and the elaboration of digital auxiliaries, the evaluation of our own competences to approach a new didactic experience and, especially, the knowledge of the performances and of the efficiency of the CABRI 3D software in the activity involving the students.

The idea of this present paper has started from the desire to share to our colleagues, the Mathematics teachers, the experience acquired in the already mentioned collaboration. To be more exact, we wanted to share general information about the CABRI 3D software and some of the didactic opportunities given by its use in the classroom. The information regarding the creation of other teaching systems in the domain of the Mathematics educational software, their knowledge and the chance to access them can offer to our colleagues the chance to find solutions for their research in what regards the mixing of the traditional teaching methods with the modern ones, and to identify the motivation resources that make the students find the use of Mathematics in everyday life. To say even more, the contact with this information leads to reflection, experimenting, comparisons and analysis with positive effect on the capitalization through symbiosis of the multiple alternatives offered to the didactic activity by the TIC instruments, and also of the interest manifested without reserves by the young people towards IT.

## **1 A short history of the CABRI géométrie software**

In 1985 the team from CNRS - “Centre National de la Recherche Scientifique”, the “Joseph Fourier” University from Grenoble, created **CABRI – GEOMETRIE**, the first software dedicated to the study of the Geometry with the help of the computer. The CABRI technology was designed and destined to students and teachers, equally, starting from the

pre-university educational system with the purpose to sustain and to facilitate the necessary efforts to understand Geometry, but also to stimulate the interest of learning it. In 1988 the French Educational System gave the team that created the software the excellence award and recognizes CABRI géométrie as a real value brought to the quality of the French education in what regards Mathematics. They promote it and finance both teachers' formation and its distribution in schools. Starting with 1990 the "parents" of the CABRI software have extended the research team collaborating with scientists, computer researchers, mathematicians, practicing teachers in the domain of the education with the purpose to develop and to extend the project in the study of Geometry in the tri-dimensional space, in parallel with the improvement and the diversification of the performances in the field of Informatics. In 2000 Jean-Marie Laborde, the director of the research team and the spiritual father of the second version of CABRI II PLUS, developed the CABRIOLOG Foundation through which they distribute all over the world today's versions of **CABRI 3D**, **CABRI II Plus**, **CABRI Jr.** and **Utilitaires**.

In what regards the education and pedagogy, the educational software **CABRI – GEOMETRIE** revolutionized the teaching – learning – evaluation process of the Euclidean geometry and the traditional approaches from the pre-university educational system from many European, American and Asian countries. The utility of the CABRI software in the didactic activity and their efficiency regarding the results of the learning are generated by:

- the full agreement with the theoretic mathematical support;
- the content of the curricula and of the school textbooks;
- the performances in the Informatics domain that stimulate the students' creativity and develop their capacity of space projection, but also
- the capitalization of the relationship that today's adolescents have with the world of the digital image.

The CNRS collaborations with teams from ENGLAND, the USA, BOSNIA, CHINA, THE CZECH REPUBLIC, DENMARK, GERMANY, ITALY, KOREA, PORTUGAL, POLAND, SPAIN, and VIETNAM made CABRI to become one of the pilot software presented in numerous school textbooks and used practically in teaching Geometry. There have also been extended the download possibilities and access to the tutorial in the languages of these countries.

The operational qualities of the CABRI software have been recognized worldwide. The experimentation of teaching Geometry in class

with the help of software has generated numerous debates that have imposed the organization of two international conferences dedicated exclusively to the CABRI program, in Sao Paolo in 1999 and Montreal in 2001. In 2002 the Company Texas Instruments from USA included on its computers Graphing an adapted version of the CABRI program, fact that is a real success regarding the recognition of the performances of the software.

## **2 CABRI software – applications serving Pedagogy**

The teaching – learning – evaluation process of the Euclidean geometry means sustained efforts on the part of the teacher taking into consideration the necessity to project and to prepare, depending on the potential of the students group, the theoretical support and the practical applications that assure the conditions of a good understanding of the notions and of the concepts, the achievement of the right figures, the consumption of time required for the modelling and deployment bodies (with the help of the paper, cardboard or plastic), highlighting the difficulty of building components, the concern for practicing and learning geometrical reasoning, cultivation of native skills, etc. The applications of CABRI géométrie facilitate learning, being real instruments that help to overcome many difficulties, some of the advantages being: making geometric constructions on the computer's monitor in exceptional graphics, highlighting the component elements and their controlled mobility, animation views, saving and printing drawings, etc.

The CABRI Géométrie II and CABRI D3 applications are friendly educational software that can be successfully used for teaching Geometry both in groups and individually. The browse of the digital process through which are made the geometric constructions, the impact of their possibilities to move, the spatial visualization from different perspectives motivate and challenge the students to explore, to make their own discoveries, to analyse the obtained results. Subsequently these attitudes and reactions lead to the heuristic dialogue, the supporting of the opinions, personal ideas, expressing assumptions, figures or bodies, geometric intuition properties, testing and analysis, synthesizing conclusions.

The CABRI teaching system has a solid theoretical base developed by specialists in Geometry. The software's essential quality is that the exploration of the geometrical properties is possible only with the compliance with all the rules imposed by the theory. The CABRI

applications assure the interactive teaching. During learning and solving tasks, students are faced with new situations that incite and encourage them to analyse, to apply theoretical results, to identify or to propose solutions, to issue opinions and argument them, to make calculations and to check them.

The impact of the use of CABRI applications in the teaching Geometry process, either in the secondary school or in high school has immediate benefits for the students:

- increased confidence in the personal understanding and learning abilities,
- acquiring skills to discuss heuristically with the teacher, with the colleagues and with software as well,
- the development of the imagination and of the space visualization ability,
- practicing the connection making between theoretical results and practical applicability,
- the shortening of the learning time,
- the assimilation according to personal pace, implicitly determining the quality of learning outcomes,
- boosting confidence in the results of teamwork,
- Increasing self-esteem through the assessment of personal contribution to the results, etc.

The long term impact of learning Geometry assisted by CABRI is represented by the fact that the motivation for individual study, professional and school improvement is increased and also the students' self trust in their own capacity to deal successfully with tests, with Math contests and with life exams in general is raised.

The CABRI applications offer the students the necessary instruments for systematic "exploration", for the understanding and deepening of notions, concepts and geometric reasoning. Through the capitalization of the students' interest in the computer, after a short initiation depending on the topic of study, they:

- discover the Geometry's fundamental elements (dots, lines, segments, circles, planes, semi-planes),
- understand and differentiate the classes of remarkable polygons, polyhedra and round objects,
- they construct simple or elaborate geometric figures and objects and view their different spatial perspectives,
- they experiment the generation of fundamental geometric spaces,

- they discover and learn through practical experiment the properties of the geometric transformations,
- they attach numerical coordinates to the points in plane or in space, they determine algebraic equations for planes, they measure angles, perimeters, circumferences and angles, etc.

CABRI offers to the teacher instruments that help him:

- to design the teaching – learning – evaluation process,
- to prepare the activities that introduce new concepts,
- to do elaborate organization of the learning sequences destined to training, memorizing and recapitulation,
- to demonstrate fundamental geometric theories, sentences and properties,
- to generate practically the geometric places,
- to develop polyhedral or round objects and their reconstruction,
- to create work charts that contain: drawings, explanation boxes, example exercises, training exercises, helping items, short tests,
- to design tests that include informing/explanatory texts, objects or geometric objects with high quality graphic aspect,
- to solve the problems required by the Math syllabus and also the ones that interfere with other disciplines: Physics, Geography, Art,
- to evaluate the degree in which the proposed objectives have been achieved,
- to highlight explicitly the intricate sections determined in different bodies by different planes,
- to solve and print all the files that contain CABRI documents, etc.

**CABRI 3D** software offers the teachers multiple possibilities to adapt teaching and learning to the rhythm of the students group and the chance to learn at the right time and place. The CABRI applications offer the possibility that the work tasks to be installed on a single computer or on an entire network. To increase the efficiency of the things the students learn and to shorten the necessary time for the acquisition of the skills, to launch challenges and to raise the interest in solving the working tasks, the teacher has the freedom to approach the students directly, in groups or individually. Using projection equipment for the computer, there is the chance to involve the entire class in finding individual solution for the same task or problem (for example in the evaluation step).



### 3 The characteristics of CABRI applications pack

The performances of education software are appreciated after the analysis of the advantages that it brings in comparison to the traditional methods. In its turn, the analysis of the advantages has as base the evaluation of its capacity to meet a set of requirements regarding the pedagogical exigencies, informatics characteristics, ergonomical advantages and the design's quality related to the necessities and the expectations of the two leading actors that collaborate in the process of learning – the teacher and the student.

CABRI 3D is the software designed to be used directly in the process of teaching – learning the Euclidean Tri-dimensional Geometry and subsequently developed as variety and performances through the inclusion of the instruments for interactive exploration and of the drag-and-drop ones that facilitate:

- the view of the geometrical constructions under different angles and perspectives,
- the animation of an element, of a construction or of several constructions at the same time,
- the development and the representation in prospect of the objects,
- the constructions' replay step by step,
- the study of the characteristics of a construction's elements through animation and move with the advantage that it preserves its established initial characteristics,
- the possibility to integrate the numerical data and the algebraic equations, fact that practically extends the study of Geometry and the analytical approach.

**CABRI 3D is dynamic and interactive**, namely it holds the essential characteristics necessary to a **software destined to computer assisted instruction**. In the contemporary education, the advantage brought to the educational process by this valuable didactic method, that is meant to facilitate understanding and learning, to attract and motivate the student's involvement in the lesson, are unanimously known. **CABRI 3D** satisfies the following requirement- the interactivity- through the fact that the constructions and the figures built on the monitor are dynamic and not static like the ones drawn on the blackboard or on a piece of paper. The interactive communication between the software and the user is carried out permanently during the period of time in which the working task is followed up. The student and the software play in turn the part of transmitter and receiver of communication, each of them receiving an immediate and

complete feedback. CABRI 3D also ensures the interactivity's efficiency when used in teaching new knowledge, because it facilitates a dialogue between the student and the program, just like the teacher-student dialogue. The interaction can be controlled by the computer (tutorial dialogue), or by the pupil (investigation dialogue). It is useless to add that the interactivity is ensured by the Informatics and pedagogical performances of the software but, its efficiency is directly dependent on the teacher's skills to capitalize the program's properties in designing the teaching sequences and in sharing working tasks.

**CABRI 3D is a drill and practice software** because it offers the possibilities to access supplementary explanations and demonstrations to a theme proposed to learning. This quality of the software allows the teacher to monitor the pupil's progress during an individual or group working task that has as purpose learning some notions, techniques and procedures or building some specific skills. The application allows each student to work in a personal manner and to receive the assessment of the given answer through the dialogue or collaboration with the software.

**CABRI 3D is a software for testing knowledge.** In the complex training background offered by the software the knowledge testing is integrated as an active component. The testing is done at different moments and stages of the pupil's interaction with the program and the feedback is immediate.

The **CABRI 3D** application is unique through the quality of the didactic content, the pedagogical approach, the special computer and technological performance. In the offer for educational software destined to teach computer assisted Mathematics, this set of qualities that individualizes **CABRI 3D** application are completed by the following characteristics.

**CABRI 3D is easy to use software because:**

- the interface combines simplicity, order and clarity, fact that makes learning possible in a shorter period of time,
- the understanding and access of all the facilities offered by the application are possible with minimum digital competences,
- in the initial learning step there are necessary basic Geometry knowledge,
- it allows the possibility to customize the menus through elimination or adding macro – orders based on the group's needs (the study task, age level) and the context of its use.

**CABRI 3D is complete geometrical software** including the study of:

- the Euclidean Geometry in plane and in space,
- the geometrical transformations,
- the vector Geometry,
- the analytical Geometry (through the possibility to show the coordinates of the points and the insertion of the equations of the basic geometrical figures: straight, tapered, flat and their use in reasoning and calculations).

#### **4 CABRI 3D is a software that allows learning through discovery.**

The fundamental geometrical properties and results, and especially those of the remarkable geometric places that represent real difficulties for the teachers in the teaching activity and for the pupils in the process of correct understanding, can be easily discovered with the help of CABRI 3D application through the analysis of:

- the relations and the interrelation among the elements of the built geometrical figures,
- the animation of the made constructions and the dynamic view of the different positions,
- the observation of the evolution of the variable elements regarded to the invariable ones.

#### **5 The performances of the CABRI 3D software**

Beside these performances that are common to all the applications from the **CABRI géométrie** family, the essential characteristic of the **CABRI 3D** application is the **capacity of the computer modelling of the study of Geometry in the tri-dimensional space**. **CABRI 3D** has inserted in the program **digital and geometrical instruments** that make possible:

- elementary and complex constructions in the tri-dimensional space (with the help of straights, planes, polyhedrons and round objects),
- the study of the properties of the main classes of polyhedrons and round objects,
- the view of all the polyhedrons,
- the determination of the section polygons of the planes with different polyhedrons,

- the measuring of the distances, lengths, areas, volumes and angles and their use in calculations.

CABRI 3D is the only 3D visualization instrument that through the search in the menu options ensures:

- the step-by-step replay of the succession of a construction's stages,
- the view of the constructions from different angles and perspectives,
- the move of a construction's elements and implicitly the modelling of physical phenomena,
- the appreciation of the dimensions through the observation of different positions of the same construction,
- the continuous rotation of a construction.

All these performances of the **CABRI 3D** application offer the certainty that it is ensured the correct understanding of the notions, concepts, methods and solving techniques of the problems by all the students, regarding the personal possibilities to observe, receive and learn.

Necessities to use: CABRI 3D can be downloaded at the internet address: [//www.cabri.com/](http://www.cabri.com/) and the program works efficiently for Windows 95, 98, Me, 2000, XP and Mac OS X 10.3. For acceptable performances are recommended a minimum processor of 800Mhz and a graphic board based on Vidia GeForce 2, ATI Radeon 7000. It has been practically demonstrated that the CABRI 3d software is efficiently used even on less powerful configuration.

## 6 Classroom applications

In the multitude of notions and reasoning types that are necessary to find the solutions to the geometrical problems, the ones that contain the determination of the sections resulted from the intersection of different planes with tri-dimensional objects are difficult to learn and understand by the pupils.

The efficiency of CABRI 3D software and the impact of its instruments can be convincing in a practical demonstration or initiation training. In order to exemplify the quality of the constructions we inserted the files done by my students for solving three problems of this type.

### **Problem 1**

*Let  $[ABCD A'B'C'D']$  be the cube with an "a" side, the plane  $(C'MN)$ , where  $M$  is the middle of the segment  $[A'B']$  and  $N$  the*

*middle of the segment  $[BC]$ . The shape and the area of the determined section in the cube by the plane  $(C'MN)$ .8 are required.*

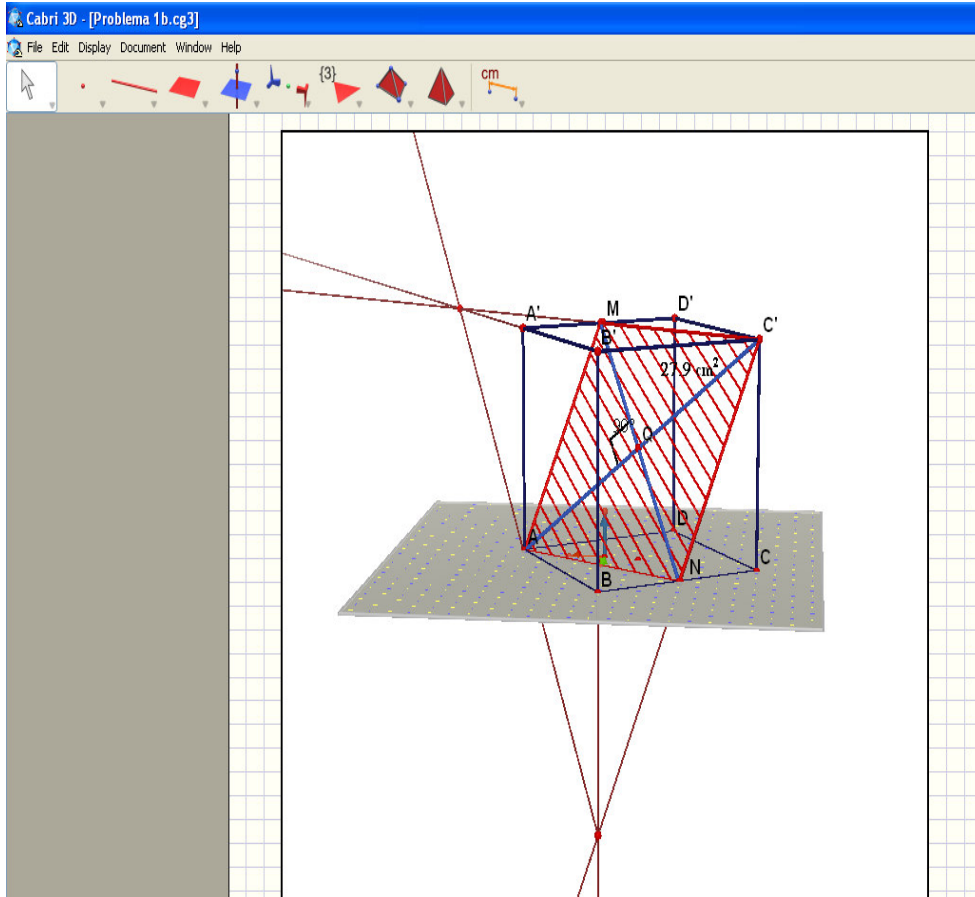


Figure 1.

**Problem 2**

*Let  $[ABCD A'B'C'D']$  be the cube, the points  $M$  and  $N$  are the middles of the  $[BC]$  and  $[AA']$  sides, and  $O$  the centre of the  $[A'B'C'D']$  face. There are required the shape and the area of the determined section in the cube by the  $(MNP)$  plane.*

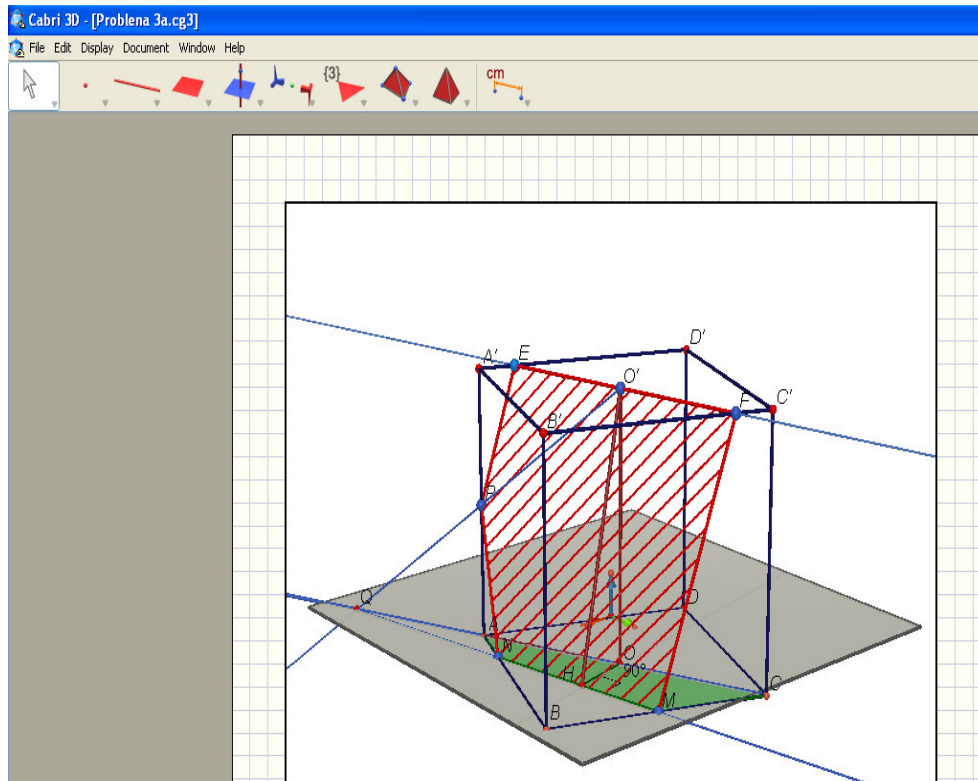


Figure 2.

**Problem 3**

Let a circular straight cone be with an  $r$  radius and  $h$  height and the section determined in the cone by a parallel plane with the base that is situated at the  $x$  distance regard to the top. It is given the cone that has as base the determined section and the top in the middle of the given cone. It is required to find the  $x$  distance so as the volume of the built cone to be maximum and the total area of the cone to have maximum volume.

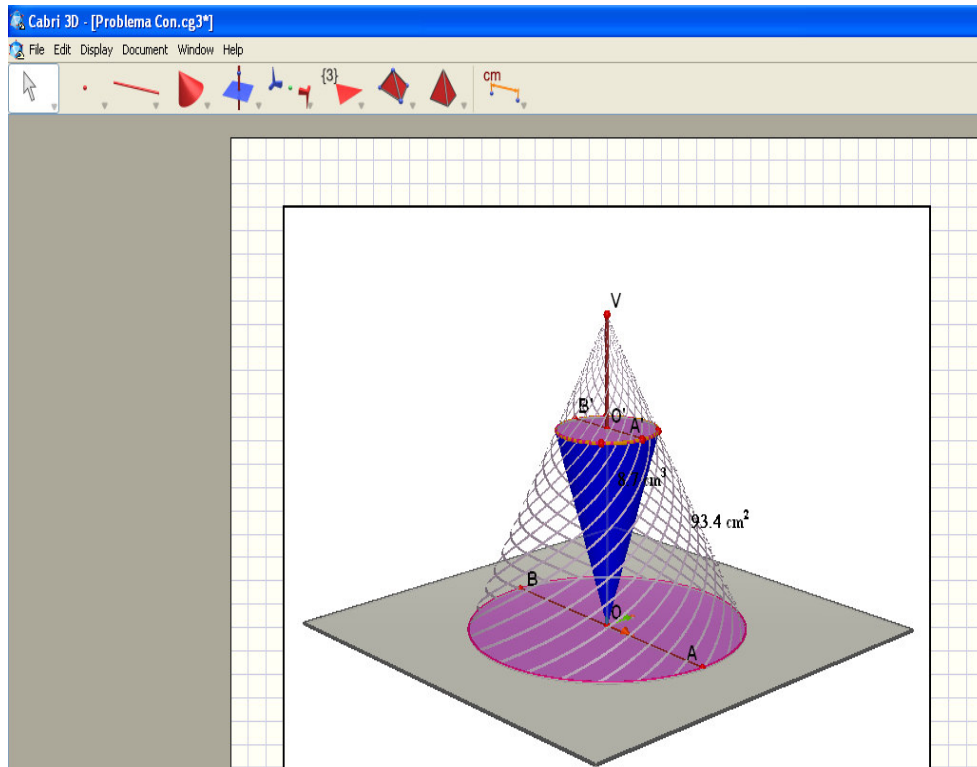


Figure 3.

## Conclusions

The strategy to organize teaching, with the use of computer and educational software, even though it is attractive and has undisputed virtues, it often gives birth to a series of doubts in what regards the quality of the results.

All the didactic experiments have proved that using the CABRI 3D application in the classroom the impact on the students is positive and there are much better results in the learning process in comparison to the ones obtained when using traditional methods. The quality of the results is generated by the motivation growth in what regards the learning of theoretical knowledge through the checking and the view of the properties, the improvement of the efficiency in solving problems, through the dialogue with the software and through the interested engagement in the acquisition of the necessary skills for the efficient use of the program.

The whole CABRI software package, but especially the last version, CABRI 3D, satisfies the user's individual requirements through the value of the scientific support, the pedagogical and computer accessibility, the flexible adaptability to the

group's needs and the using context. An experiment with the classroom's cooperation, even very short, leads to the conclusion that the software satisfies both the teacher and the student's expectations through the variety of the methods that can be approached so as the wanted results to be attained.

For the teachers, Geometry continues to be the "queen of Mathematics" but the pupil is sometimes confused at the first contact with its world and must be helped step by step to discover its beauty. CABRI 3D offers the teacher the opportunity to design the Mathematic content "packed" differently, the "wrapper" having the quality of catching the students' eye and to incite them to "know" its content.

The information, the applications from the POWERPOINT presentation attached to the paper and the arguments that this work brings are only some examples from the variety of demonstrations that prove that the CABRI 3D software is an useful and practical tool that makes the teacher's and the pupil's efforts more efficient in the study of the Euclidean Geometry. The software's solicitations, that the theoretical results must be rigorous, oblige the users to dynamic interactivity, fact that in time leads to the correct assimilation of the geometrical knowledge, to the solid learning of the techniques and methods used to built figures and complex geometrical constructions, to the learning of the solution algorithms of different classes of problems, to the practice and acquisition of the creativity skills that are necessary in contests and exams.

Like any other auxiliary, CABRI 3D cannot replace the efficiency of the scientific and emotional-affective dialogue that exists in the classrooms between the teacher and the pupils during the Math classes, the sustained individual and serious work that is so necessary to the pupil for the correct learning of Mathematics. The professionalism and the teacher's devotion in sharing with generosity the knowledge and the gained experience will always remain the most important conditions that ensure the success of the students' results, yet by using CABRI 3D the efforts will be substantially reduced and the satisfaction will be bigger and immediate.

## References

- [Alb08] **I. Albulescu** – *The activity of the teacher between routine and creativity*, 2008 - The Paralela 45 Publishing House  
[\*\*\*] <http://www.cabri.com/fr/>  
[\*\*\*] <http://www.rhombus.be/index.html>  
[\*\*\*] [www.matematica.it/tomasi/figure3d/index.html](http://www.matematica.it/tomasi/figure3d/index.html)  
[\*\*\*] <http://www.chartwellyorke.com/cabri3d/introtocabri3d.htm>  
[\*\*\*] The tutorial of CABRI 3D software