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EXPERTISE – SPECIFIC SKILLS DEVELOPED BY THE APPLICATION OF INFORMATION TECHNOLOGY IN LEARNING PROCESSES
EKSPERTIKA-AFTËSITË SPECIFIKE TË ZHVILLUARA NGA ZBATIMI I TEKNOLOGJISË INFORMATIKE NË PROCESIN MËSIMOR

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PËRMBLEDHJE
Në këtë punim identifikohen karakteristikat e rëndësisë së Teknologjisë Informatike duke reflektuar mbi progresin e bërë nga profesionistët në transformimin e rolit të tyre në realizimin e reformave arsimore, duke përfshirë edhe renovimin e rolit të orës mësimore. Me qëllim të theksimit të zhvillimeve të mëtejshme dhe për të kuptuar rëndësinë, ky studim fokusohet në identifikimin e rezultateve të mësimdhënies dhe të nxënies të cilat nxënësit i arrijnë kur çasja e mësimdhënies e përdorur nga mësimdhënësit e tyre është e kombinuar me Teknologjinë Informatike: aftësitë teknologjike (nga përevetësimi i aftësive bazike teknologjike deri te aftësitë multimediale); aftësitë kognitive dhe metakognitive që rezultojnë nga zgjidhja e problemeve autentike; aftësitë e transferueshme në situata të tjera; përmbajtjet lidhur me njohuritë kurrikulare; aftësitë bashkëpunuese; dhe aftësitë e inovacionit. Supozimi është se edhe interesat themelore të nxënësit edhe pritjet sociale të zhvillimeve shoqërore të bazuara në dije, mund të realizohen me anë të integrimit të softwerit arsimor dhe mësimit të matematikës.

SUMMARY
This study identifies the characteristics of the importance of Information Technology reflecting on the progress made by professionals in transforming their roles to accomplish educational reforms, including the renewal of the role of the classroom learner. With an aim to indicate further developments and understand its impact, the present study focuses on the identifying of teaching and learning outcomes what students are learning when the approach is used by their teachers in combination with ITs: technology skills (from the acquisition of basic technology skills to multimedia production skills); cognitive and metacognitive skills resulting from authentic problem solving, skills highly transferable to other situations; curriculum-related content knowledge; collaborative skills; and innovation skills. The assumption is that both the learner's basic interests and the social expectations of the emerging knowledge-based society can be met by thoughtful integration of educational software and mathematical scenarios.
Key words: IT, Mathematics Education, Learning processes, Curriculum.

INTRODUCTION

One of the most important issues related to educational change and educational innovation is the incorporation of Information and Communication Technologies (ICT) (Hoyles, Noss, & Kent, 2004). It is widely recognized that the use of ICT could offer students and teachers various ways to represent and explore not only mathematical problems or concepts. There is also evidence that different tools might offer learners different opportunities to think of problems in order to represent, explore, and solve those problems. In this way, ICT constitute an essential tool for teachers, since it can be used as: a) an educational method to support student learning; b) as a personal tool to prepare material for his/her lessons, to manage a variety of projects electronically and to search for information; c) as a tool to collaborate with other teachers or colleagues (Da Ponte, Oliveira, & Varandas, 2002). Within research project "*Learning to teach geometrical transformations*"[1] in the FFP of University of Barcelona, has developed a program for teaching mathematics for prospective teachers, which is accompanied by dynamic educational software. This is the case for mathematics as teaching subject in the nine-year compulsory education.

Therefore, from a constructivist viewpoint (Cobb, Stephan, McClain, & Gravemeijer, 2001), educational software integration into undergraduate students' teaching practice is a crucial factor for teachers' future 'establishment' and improvement in classroom practices. During the 2005-2006 spring semester, a six month course on mathematics teaching was organised by the researchers with the aim of incorporating ICT and especially designed mathematical scenarios (Thaqi, 2009) in students' teaching approaches. In general, research results indicate that it is important for teachers to incorporate in their teaching scenarios the systematic use of several computational tools to help students develop mathematical comprehension and problem solving proficiency.

What type of tools should students utilize and how they should use them to enhance their problem solving approaches? What types of tasks should students work and discuss in order to transform technological artefacts into effective problem solving tools? What types of mathematical reasoning do students develop as a result of using a particular tool in problem solving activities? The discussion of these and similar questions is relevant to orient or guide teachers during the design and implementation of activities and tasks that foster the use of computational tools. The aim of this article is to identify dimensions and processes that characterize students' problem solving approaches that foster the use of several computational tools. In this context, we identify and discuss common mathematical features that distinguish students' use of computational tools to solve problems. To this end, we focus mainly on problems where students use the tools to construct a dynamic model of the problems. At that moment, the model is used as a departure point to look for mathematical relations that become important to solve and extend the problem.

[1] *Investigation "Aprender a enseñar las rtransformaciones geometricas - Learning to teach geometrical transformation "*; Author: Xhevdet Thaqi, under the guidance of Dra Nuria Rosich and Dr Joaquim Gimenez; period 2006 -2008, FFP of UB.

THEORETICAL BACKGROUND

Constructivism is considered primarily as an epistemological approach on the formation of knowledge. Delval (1997) notes that the most important and original feature of this approach is that attempts to explain the formation of knowledge in the interior of the subject, that is, it helps to understand what is what happens in the mind of the individual where this is new knowledge. In this sense, learning involves the creation of meaning from experience, so learning refers to combine, compare, or "trade" between the knowledge that comes from outside and what is inside the student (Hernandez, 1997). According to the constructivism theory, Schoenfeld (1998) argues that whenever the student is actively involved in an activity then s/he is more likely to learn its content, while Cobb et al. (2001) explains how learners make sense of their environments and experiences to create their own knowledge. However, this process requires teachers to pose meaningful and worthwhile tasks to facilitate students' learning. Koehler and Mishra (2008) suggest "…*a curricular system that would honour the complex, multi-dimensional relationships by treating all three components in an epistemologically and conceptually integrated manner*" (p.1020), and they propose an approach which is called '*learning technology by design*'.

RESEARCH METHODS AND APPROACH

This research was supported by a research explanatory field and quasi – experimental design, because we proceed to characterize, describe, evaluate and interpret the data obtained directly from reality through the application, both the control subjects as group subjects experimental instruments designed research to Metacognition variable. Also corresponds to the special project mode, this category includes jobs that lead to tangible creations, educational support materials or technology items that can be applied to solve problems correspond to cultural needs and interests are characterized by their significant innovative value. The population consisted of 13+14 students – prospective mathematics teachers. The groups included students of both sexes, aged between 18 and 23. Importantly, all students have skills in computer use.

The variable considered in the study was metacognitive skills, defined as the awareness, ability to control, monitor and reflect on the learning process of the student we called experTICe skills. For the operationalization of the computerized system developed variable provided a record of each student interaction, which were required the following indicators: routes taken (route navigation), number of errors, number of times seeking help, making notes or sketches, execution and supervision of the grade earned. Data supplied by the individual recording were used to identify the routes followed each student during the interaction, and thus interpret both the particular skills of the students to face the tasks that supplied the program (within-subject assessment), as executions each of the students who interacted with the program compared to each other (intra-group evaluation). To assess experTICe skills using students during their learning the instrument adapted from Sanchez (2000), which was applied as pretest and posttest to both groups. The dimensions considered for the report were: 1. Planning: includes the design of strategies to achieve the proposed objectives and study the conditions that must be resolved; 2. Monitoring: refers to the control exercised while apply in strategies to solve a problem or situation; 3. Evaluation: a review of results to establish if the solution corresponds to the objectives.

A PROBLEM-SOLVING FRAMEWORK

An example is used to illustrate elements of a framework to organize and guide students' use of computational tools to represent and explore the area variation of an inscribed parallelogram. Another example of a task analysed in terms of the framework appear in the appendix. In particular, we distinguish episodes that show the relevance that it has for students to comprehend and think of the problem statement in terms of mathematical resources. This initial comprehension of the task becomes crucial to construct a dynamic representation of the problem that can help them visualize parameter behaviours. The NCTM (2009) identifies both making sense and reasoning as crucial processes that students need to develop in their problem solving approaches. The exploration of dynamic models of the task provides useful information for student to think of the problem in terms of analytical and geometric knowledge, and to reflect on the concepts and processes that appear throughout all episodes.

The task: Given any triangle ABC, inscribe a parallelogram by selecting a point P on one of the sides of the given triangle. Then from point P draw a parallel line to one of the sides of the triangle. This line intersects one side of the given triangle at point Q. From Q draw a parallel line to side AB of the triangle. This line intersects side AC at R. Draw the parallelogram PQRA (Figure 1).

What does it happen to the area of inscribed parallelogram APQR when point P is moved alongside AB?

Is there a position for point P where the area of APQR reaches a maximum value? (Justify)

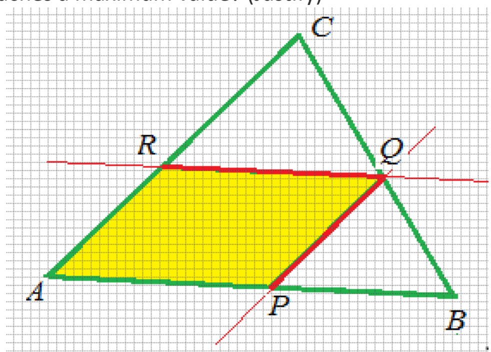

Figure 1. A parallelogram inscribed into a given triangle

Comprehension stage.

If students are to comprehend and make sense of the situation or problem, they need to problematize the problem statement. That is, they need to think of the problem in terms of questions to be explored and discussed with other students and the teacher. For example, in this problem, the comprehension stage involves discussing questions as:

What does it mean for any given triangle?

What information does one need to draw any triangle?

Are there different ways to inscribe a parallelogram into a given triangle?

For example, in Figure 1, one can draw from P a parallel line to CB (instead of AC) and this line intersects side AC and from that point of intersection, one can draw a parallel line to AB that intersects BC, thus, the two intersection points and point P and B form an inscribed parallelogram, the problem solver can ask: how is the former parallelogram related to the one that appears in Figure1? Do they have the same area? How can I recognize that for different positions of point P the area of the parallelogram changes? This problem comprehension phase is important not only to think of the task in terms of using the software commands; but also to identify and later examine possible variation of the task.

Problem Exploration Episode. The comprehension phase provides useful information to identify way to represent and explore the problem. The use of a Information Technology (TIC-Tecnología de Información y Comunicación) becomes a powerful means to represent and construct a dynamic model of the problem. To begin with, students can draw a triangle by selecting three non-collinear points. Thus, they can discuss the conditions needed to draw a triangle. In addition, the use of the software allows them to move any vertex to generate a family of triangles. In this case, they can select a point P on side AB to draw the corresponding parallels to inscribe the parallelogram. With the help of the software it is possible to calculate the area of the parallelogram and observe area values changes when point P is moved alongside AB. Thus, it makes sense to ask whether there is a position of P in which the area of the inscribed parallelogram reaches either its maximum or minimum values. By setting a Cartesian system with the software, it is possible to construct a function that associates the length of segment AB with the area value of the corresponding parallelogram. Figure 2 shows the graphic representation of that function. That is, the domain of the function is the set of values that represents the lengths of AP when point P is moved alongside AB. The range of that function is the corresponding area values of the parallelogram associated with the length AP. With the software, this graphic representation can be obtained by asking for the locus of point S (the coordinates of point S are length AP and area of APQR) when point P moves along the segment. Here, it is important to observe that the graphic representation can be obtained without defining explicitly the algebraic model of the area change of the parallelogram.

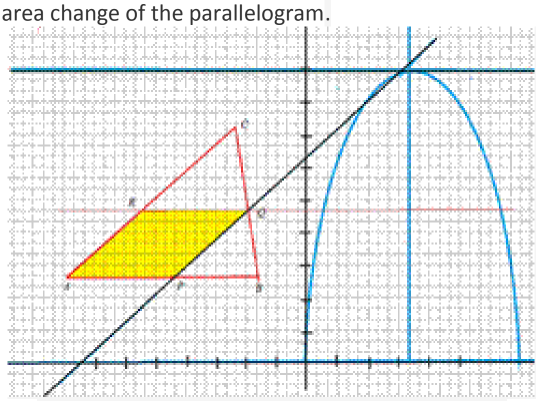

Figure 2. Graphic representation of the problem

This graphic approach to solve the problem provides an empirical solution since visually and numerically it is possible to observe that in the given triangle the maximum area of the inscribed parallelogram is obtained when P is situated at 3.66 cm from point A. Here the area value of the parallelogram is 6.56 cm^2. Indeed, based on this information a conjecture emerges: When P is the midpoint of segment AB then the corresponding inscribed parallelogram will reach the maximum area value.

Analytical approach. In this approach, the students' initial goal is to represent and examine the problem in terms of algebraic means. The use of the Cartesian system becomes important to represent the objects algebraically. Also, the use of the software provides directly the equations associated with the lines that are needed to determine the expression of the parallelogram area. The problem can be thought in general terms as it is shown below.

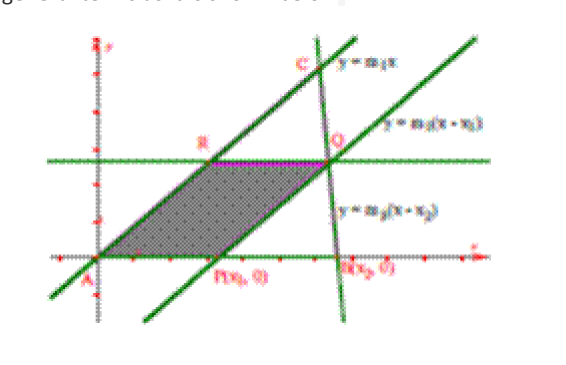

Figure 3. Algebraic model of the problem

Without unloosing generality, we can always situate the Cartesian System in such a way that one side of the given triangle can be on the x-axis and the other side on line $y = m_1x$ (Figure 3). Point P will be located on side AB and its coordinates will be $P(x_1, 0)$. Point $B(x_2, 0)$ is vertex B of the given triangle (Figure 3). Based on this information, we have that the equation of line that goes through P and Q, and the equation of line BC is:

$$y = m_3(x - x_2).$$

Solving the system of equations associated with lines PQ and BC which leads to:

$x = \dfrac{m_1 x_1 - m_3 x_2}{m_1 - m_3}$, then to obtain the y-coordinate of point Q, substituting this value in $y=m_1(x-x_1)$. That is:

$y=\dfrac{m_1 m_3 (x_1 - x_2)}{m_1 - m_3}$ (this value corresponds to the height of parallelogram APQR). Then, the function area will be

$A(x_1)= \dfrac{m_1 m_3 (x_1^2 - x_1 x_2)}{m_1 - m_3}$ (quadratic function whose roots are 0 and x_2). Also, this function has a maximum value if and only if $\dfrac{m_1 m_3}{m_1 - m_3} < 0$.

We are assuming that $m_1 > 0$. The assumption on the triangle location guarantees that m_3 and $(m_1 - m_3)$ have opposite signs. By a symmetric argument, $A(x_1)$

reaches its maximum at the midpoint of the interval [0, x_2] that is, at $x_1 = \frac{x_2}{2}$.

To determine the maximum value of this expression by using calculus concepts, we have that: A'(x1) $= \frac{m_1 m_3 (2x_1 - x_2}{m_1 - m_3}$ now, the critical points are obtained when A' (x_1) = 0, we have that $x_1 = \frac{x_2}{2}$ which is the solution of the equation, then the function A(x_1) will reach its maximum value $x_1 = \frac{x_2}{2}$ (A''(x_1) $= \frac{m_1 m_3}{m_1 - m_3} < 0$). Thus, this result supports the conjecture formulated previously in the graphic approach.

A Geometric approach. The focus of this approach is to use geometric properties embedded in the problem representation to construct an algebraic model of the problem. For example, in Figure 4, it can be seen that triangle ΔABC is similar to triangle ΔPBQ, this is because angle PQB is congruent to angle ACB (they are corresponding angles) and angle ABC is the same as angle PBQ. Therefore, we have that $\frac{PB}{AB} = \frac{QN}{CM}$, that is, if AP = x and AB = a, then $\frac{a-x}{a} = \frac{h_1}{h}$. Based on the former relation, $h_1 = \frac{h(a-x)}{a}$, area of APQR can then be expressed as A = xh_1, this latter expression can be written as $A(x) = x \cdot h - \frac{h \cdot x^2}{a}$. This expression represents a parabola.

$A(x) = h - \frac{2hx}{a}$, now if A'= $h - \frac{2hx}{a} = 0$, then x = a/2. Now, we observe that A''< 0 for any point on the domain defined for A(x), therefore, there is a maximum relative for that function.

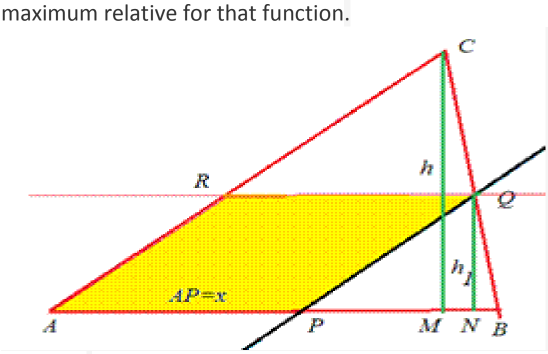

Figura 4. *Geometric properties constructed an algebraic model*

Integration skills. It is important and convenient to reflect on the process involved in the distinct phases that characterize an approach to solve mathematical problems that fosters the use of computational technology. Initially, the comprehension of the problem' statements or concepts involves the use of an inquiry approach to make sense of relevant information embedded in those concepts or statements. This enquiry process provides the basis to relate the use of the tools and ways to represent dynamically the problem or situation. Thus, a dynamic model becomes a source for which to explore visually and numerically the behaviour of parameters, as a result of displacing some elements within the problem representation. In particular, it might be possible to construct a functional relationship between a variable, for example the variation of the side AP of the parallelogram and its corresponding area.

An interesting feature of this functional approach is that the model can be represented geometrically without having expressed it algebraically. The graphic representation of the task provides an opportunity for the problem solver to understand and discuss the domain of the function and the parameters' behaviours from a visual approach. For example, by moving point P alongside AB, it is observed that there will be two different positions for point P in which the corresponding areas of the inscribed parallelogram will be the same except when the point is located at the midpoint of the side AB. Graphically, it means that a parallel line to the x-axis will cut the graph in two points except when the line passes by the maximum point. At that point, the value of the slope of the tangent line to the curve will be zero. In addition, it is noted that for any triangle with side AB and P situated on AB, then the maximum area for the inscribed parallelogram will be reached when point P is the midpoint of side AB. In general, the visual and numeric approaches to the problem become important to generate a series of conjectures or relations that needs to be supported through formal arguments.

CONCLUSION

Concluding, the systematic use of computational tools in problem solving approaches led us to identify a pragmatic framework to structure and guide learning activities in such a way that can help their students develop special skills – experTICe skills. A distinguishing feature of this framework is that constructing a dynamic model of the problems provides interesting ways to deal with the problem from visual and empirical approaches. Later, analytical and formal methods are used to support conjectures and particular cases that appear in those initial approaches.

Thus, the use of computational tools provides a basis not only to introduce and relate empirical and formal approaches, but also to use powerful heuristic as dragging objects and finding loci of particular objects within the dynamic problem representation. In this perspective, prospective and practicing teachers can use the framework to focus their attention on the activities involved in each episode. In particular, they need to conceive of a task or problem as an opportunity for their students to represent, explore and examine the task from diverse perspectives in order to formulate conjectures and to look for ways to support them.

The integration of ICT in teaching-learning process should facilitate and promote the development of appropriate forms organization of specific knowledge in students, while allowing reflection on their own activities learning so that they can exercise and develop processes and cognitive skills. To achieve these objectives, the design and development of computerized systems for specific content learning should consider the combination of multiple factors that have a direct impact on the process, among which are: activation of prior knowledge, type of activities learning, presentation of information, processes, or cognitive abilities, attitudes, thought processes and evaluation.

The research results provide evidence about the use of technology to promote learning processes through the exercise and development of metacognitive skills we call experTICe skills; students access to new information according to their needs and interests, the process with the different tools offered by the system, allowing them to review the course of their interaction; know how to progress, monitor and evaluate its implementation.

It is our belief, therefore, that prospective teacher satisfaction in a learning environment that combines teaching in the university classroom and support via an appropriate learning environment plays a crucial role in the sustenance of programmes that incorporate ICT in teaching and learning. Additionally, the correlation between satisfaction and prospective teacher characteristics (learning style, attitude towards ICT and self-efficacy in the use of ICT) constitutes a crucial parameter in the improvement of the education provided. The above mentioned findings reveal that each new educational establishment needs to adopt, an evaluation programme for its provided services, in order to obtain, amongst others, the necessary data on prospective teacher satisfaction about the course's services (Elliott & Shin, 2002) so that a circled process will take place for the new course improvement. In addition, it seemed that the crucial factors for the integration of educational software and scenarios into the teaching of mathematics are the students' positive attitudes towards ICT & educational software in technological tools and mathematics.

REFERENCES

Cobb, P., Stephan, M., McClain, K. & Gravemeijer, K. (2001). *Participating in classroom mathematical practices,* Journal of the Learning Sciences, 10(1).

Da Ponte, J.P., Oliveira, H. & Varandas, J.M. (2002). *Development of Pre-Service Math. Teachers' Professional Knowledge and Identity in Working with Information and Communication Technology*, Journal of Mathematics Teacher Education, 5(2).

Delval, J. (1997). *Hoy todos son constructivistas*, Cuadernos de Pedagogía, 257, 68-84.

Elliot, K.M. & Shin, D. (2002). *Student satisfaction: an alternative approach to assessing this important concept.* Journal of Higher Education Policy and Management 24(2).

Hernandez, G. (1997). *Sinonimia y diferencia de significado*, REL 27,1.

Hoyles, C., Noss, R. & Kent, P. (2004). *On the integration of digital technologies into mathematics classrooms*, International Journal of Computers for Mathematical Learning, 9(3).

Koehler, M. and Mishra, P. (2008). *Introducing TPCK*. En *AACTE Commitee on Innovation and Technology.* Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators, New York, Routledge.

Sánchez, J. (2000). *Nuevas tecnologías de la información y comunicación para la construcción del aprender*. Santiago: Universidad de Chile..

Schoenfeld, A.H. (1998) *Toward a theory of teaching-in-context*, Issues in Education, 4(1).

NCTM, (2009). Annual Meeting and Exposition, Washington, D.C.

Thaqi, X. (2009). *Aprender a enseñar* **transformaciones geométricas** *en Primaria desde una perspectiva cultural.* phD Thesis. Barcelona University. Spain. http://www.tesisenxarxa.net/TDX-0521109-104606/.