TEACHING MATH USING CHESS AS A RESOURCE IN THE CLASSROOM

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Abstract:

This article synthesizes two studies about the creation, validation and application of didactic materials to math teaching. These materials were created between 2006 and 2008 and are based on several experiences using chess in the teaching of maths in primary education.This contribution aims to show a series of manipulatives that innovate and motivate the teaching of math with the help of chess resources. In this article the materials will be described, the game of chess will be analyzed as a resource, and its usage in the classroom will be specified.Materials containing chess elements that allow a more motivating, innovative, meaningful and fun way of teaching math are described, designed and supported in this article. Also, data about the influence of these materials on skills such as logical thinking and numerical calculation are presented. Some instructions for using these materials in the classroom are presented as a means of conclusion.

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Key words: chess, math didactics, didactic materials, math games, research.

1. Materials and educational games for teaching

Briefly, the materials will be presented as a tool for education and games will be seen as a source of interest in the classroom.

1.1.- Didactic materials and teaching

Expressions such as "educational materials" or "curricular materials' are used interchangeably or with minor differences by different authors; they are also used with expressions like "means" or "action" (Bergasa et al, 1996: 34) In this paper, we refer to both terms as synonyms meaning "all materials, equipment or devices that serve to plan, develop and evaluate the curriculum".

There are many ways to classify the curricular materials according to the the criteria being applied. Many of them are classified according to the area to which they relate:we may consider materials being psychomotor, math, language, etc ... This form of classification is useful for teachers but has the disadvantage of excessive discipline and presence of abandoned globalizing approaches. Alternative proposals are listed in Table 1.

PARCERISA (1999)	UNESCO (1998)	ZABALA (1990)
Sensory • Hearing • Visual • Audiovisual Degree of realism • Realistic • Abstract Relationship with faculty • Subordination: TV. • Insubordination: power. History	Administrative criteria • Manuals and books • Means for science education. • Resources for teaching • Physical Education. • Means for technical and vocational education. • Audiovisual. • Computer Media.	Levels of detail • First level: educational projects • Second level: materials that facilitate the sequencing of content. • Third level: textbooks or computer equipment intentionality • Orient (didactic books). • Guide (tutorials). • Propose (textbooks for proposals). • illustrate or exemplify

• Pre-technological • Audiovisual • Cybernetics Administrative • Cataloging Instructional • Didactic functions		(innovation experiences). Support • Paper (books). • Computer (PC) Audiovisual (overhead).

Table 1: Classification of Instructional Materials

Parcerisa and others (2005: 26) included as curriculum materials,

"... Proposals for the development of educational curriculum and school projects; proposals for teaching in certain subjects or areas, or at certain levels, cycles or stages; proposals for teaching students with special educational needs; descriptions of experiences of curricular innovation; materials for the development of teaching units; evaluations of experiences and I own curriculum materials, etc ".

More specifically, it proposes the following classification of educational material:

- Permanent handout: interactive board, blackboard, whiteboard, chalk, markers, eraser, notebooks, rulers, compasses, LCD projectors...
- Resource materials: maps, books, dictionaries, encyclopedias, magazines, newspapers, CDs,
  files...
- Visual or audiovisual illustrative material: diagrams, synoptic charts, drawings, posters, prints,
  recorders, LCD projectors...
- Experimental equipment and various materials suitable for conducting experiments.

The training materials must be present in the classroom at the right time and meet a number of purposes; Parcerisa (1999: 28) specifies the following:

- To approach the students to the reality of what they are expected to learn.
- To encourage the class.
- To facilitate awareness and understanding of facts and concepts.
- To synthesise and illustrate what is being exposed orally.
- To economize efforts to lead students to the understanding of facts and concepts.
- To contribute to the setting of learning through the most vivid and evocative impression caused by
  the materials.
- To provide opportunity to manifest their skills.

  The teaching materials seek to represent reality in the best way possible, for optimum achievement of educational aims of the program to which it is associated. Their basic role of mediation in the teaching-learning process is broken down into several specific functions, which can be summarized in the following:

  - Innovative, if it implies the introduction of new contents or concepts in teaching.
  - Motivator, if it captures the students' attention.
  - Organiser of reality, if it facilitates, through its presentation, the understanding the relationships between elements of reality.

- Configurator of the type of relationship the student has with the learning content.
- Controlling the content to be taught.
- Organizer: acting as organizing methodological guide organizing the formative and communicative action.
- Formative, comprehensive or strictly educational, if it helps in the learning of certain attitudes, depending on the features and use made of the materials.

For materials to be truly educational, Alsina (2004: 16) provides some criteria of interest:

 Functional value, characterized by the activity that provides the child: fit, roll, drag, etc...

 Experimental value, based on the acquisitions: recognizing shapes, sorting, measuring, etc...

 Structural value related to the development of the child's personality: play tents, build a town, etc...

 Affective value, which is characterized by affective relationships that can be established between the child and the material and how the toy can come into play with other children or adults.

The educational value lies not only on its merits, it also refers to the forms of usage. A timely usage, related to the concepts being taught, and accompanied or followed by previous considerations or reflections, is part of good practice.

The evaluation of materials should take into account all the above and, in particular, whether their usage actually helps in the acquisition of the contents and the objectives pursued. It would be important to analyse, therefore, the teaching potential of the materials. These should be arranged so that:

 They allow the student to take reasonable individual and group decisions.

 They allow play an active role that the student will undertake to meet their intellectual processes.

 They force to accept some risk, failure and criticism.

 They require students to write again, revise and refine their initial efforts.

 They engage students into applying and mastering significant rules, norms or disciplines.

 They allow the capture of the students' interests and the importance of learning.

1.2.-The game as a resource in the math class

The game refers to a recreational exercise with rules under which it is won or lost. The Larousse (2001) Encyclopedia defines it as*: "Physical or mental activity order,not imposed, which seeks no useful purpose, and that one comes to have fun or get pleasure"* (2001: 269, Book 6)

Some elements that define it are:

- It serves for fun or have a recreational function.
- There are rules that must be respected.
- It can be physical, mental or both at once.
- It does not seek any utilitarian purpose.

Play is an essential element inn the development of children. Used to have fun, identifies

moods (a child who does not play is not happy) and sets standards related to the development of personality. Also leads the child to conquer their autonomy, as well as the acquisition of behavior patterns. As said by De Guzman (1984: 53):

"Games help build a network of devices that allow the child to the assimilation of all reality, incorporating it to revive it, master it, and compensation so that the game is assimilation of reality to me."

The basic guidelines that we must follow to promote the successful implementation of educational games are (Figure 1):

- Do not present the game as a job.
- Choose the appropriate game and prepare students for the acquisition of concepts, procedures, attitudes and strategies.
- Graduate difficulty of standards to the level of mastery achieved.
- Adapt the game to the mathematical knowledge to assimilate.
- Test the game winning strategies to apply.
- Conduct simple research on the appropriate level for the students to play.

Applying these guidelines will have the advantages of:

- Improving students' attitudes towards mathematics.
- Developimg students' creativity.
- Facilitating the choice of strategies to solve problems.
- Leveraging the error as a source of diagnosing and learning for the student.
- Adapting to the individual possibilities of each student (treatment of diversity).

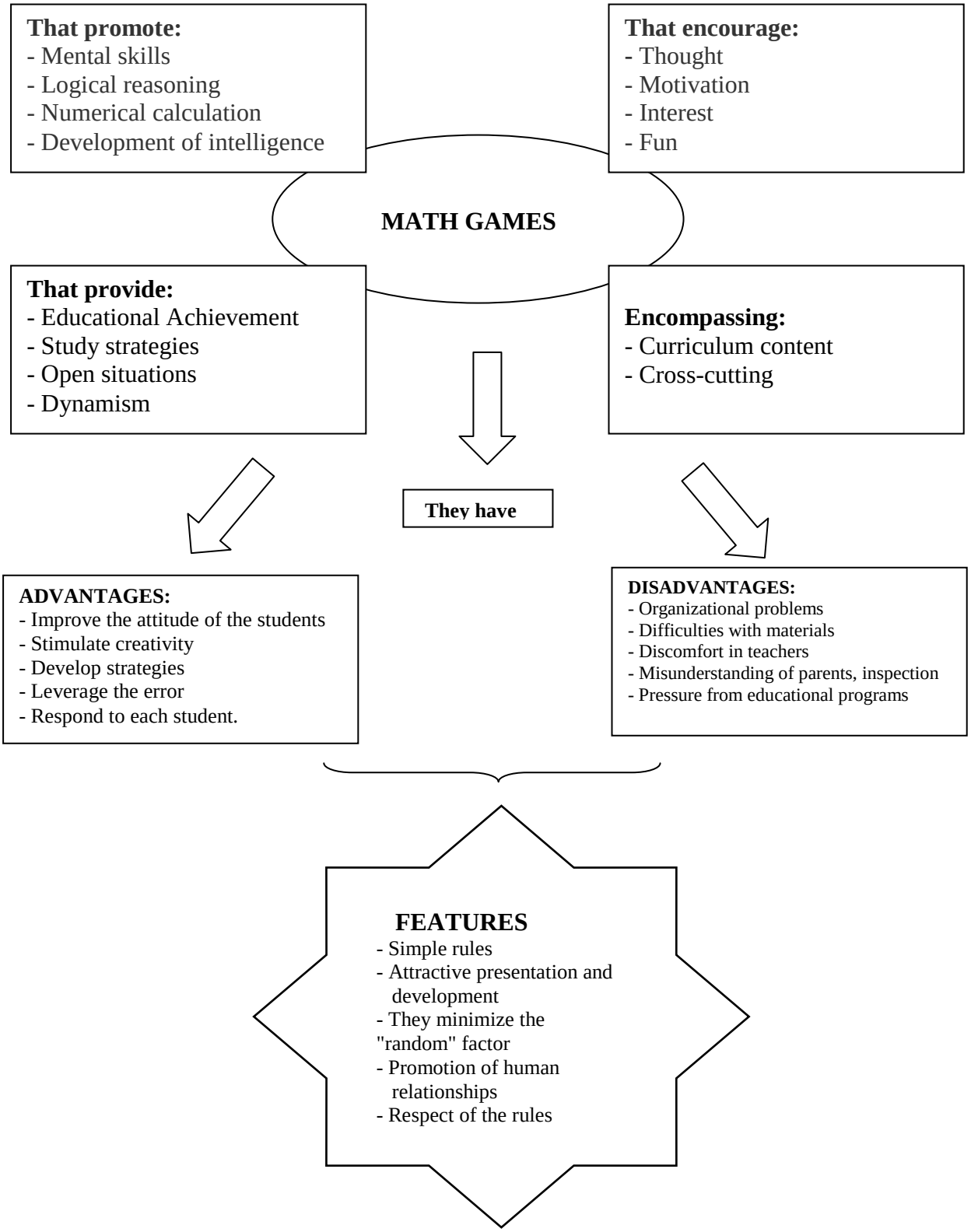

Figure 1. Considerations and games features in mathematics (adaptation of CIDE, 1998: 17)

Having recognized mathematics as an important area of the curriculum for their training, instrumental and functional status, learning does not have to be difficult if the appropriate means are used (Gairín and Muñoz, 2006). In this regard, it is essential to find the resources and teaching strategies that not only motivate students but also facilitate their learning. One

such resource is the mathematical game, which has great value as a teaching tool if it helps the development of habits and positive attitudes towards school work and trains students to deal with unforeseen situations (Carrillo and Hernán, 1998: 75) .

Math games have many features in common in terms of their educational purpose and can encourage students to begin in intellectual techniques, stimulating their deductive thinking, logical reasoning and enhancing their developing thinking strategies (Gairín Carlini, 1988). As Luis Ferrero (1991: 45) notes,

> *"Educational values of mathematical games that justify their inclusion in the classroom are linked to the development of intellectual abilities, the promotion of social relations and their motivational character."*

2. Chess as a resource in the teaching of mathematics

There is a dramatic growth of teaching chess in schools of our country. The presence of chess in schools increased significantly in the 90s (Muñiz, 1995 and Fernández Amigo, 1992) and in some cases it had already been consolidated in the 2000s (Fernández Amigo, 2002a, 2002b, 2002c, 2003 Amigo and Fernandez and others 2004), as formal learning, or integrated into the curriculum activity.

As early as 1994, it was presented by a parliamentary group the first bill that subjected Spanish Senate to debate on chess as a compulsory subject in public education centers. The proposal, despite being rejected because of "budgetary and academic complications," helped the spokespersons of the various political groups be in favor of a motion that would incite the inclusion of chess as an elective or extracurricular subject.

Many countries include chess in their educational programs and it seems that the presence of chess in the classroom will be increasingly high. But why chess in school?, why not chess and other board game?

2.1 Contributions of chess to education

Most of chess educational importance lies on the cognitive aspects. Although there is no unanimous agreement on the educational benefits that chess practice entails for the person, There are some parallelisms between the itemization of the strategies and procedures characteristic of critical thinking used in the game of chess, and the strategies belonging to metacognitive learning.

Under the approach outlined, we should get to prove the following hypothesis: "who learns to think in an organized, orderly and effective chess fashion and internalizes the technique of the game of chess, can transfer these skills to other learning and use them for making decissions in life "(A. García, 2001).

The influence of chess, both cognitively (attention, visual memory, concentration, perception, logical reasoning, spatial orientation, creativity, imagination ...) and personally (responsibility, forecasting, analysis, sportsmanship, planning, autonomy, decision control, tenacity, constructive criticism ...), supports its implementation in educational systems of many countries.

Besides the high value of chess as an educational tool, its implementation in schools is favored by two factors:

1. No special facilities or expensive equipment needs: Few sports or recreational activities require as little or require some maintenance costs insignificant as initial investment; we can say that chess is one of the cheapest sports in the world.

2. Has a great acceptance by most students: Other activities ma ity have a similar potential training but face the difficulty of its practical application and the overwhelming rejection of students.

But how can we explain such unanimous student interest in chess? The explanation is less paradoxical than it seems. Chess seen from outside and for a layman may seem a cold, passive, boring, elitist and absent of emotion and interest activity. But nothing is further from reality; chess is an exciting activity where, behind the apparent stillness of the pieces on the board, a world of plans, ideas, strategies and surprises boiling, fascinates anyone coming to find out.

The many and varied psychological, pedagogical and, to a lesser extent, chess investigations (; Lobo, 1999; Rodriguez, 2004; Martín del Buey, 1997 among others), bring us to a common conclusion: Chess has a wide range of pedagogical virtues for the development of the individual. This statement is reinforced by the UNESCO (1995), which officially recommended that all member countries incorporate chess as an educational subject in primary and secondary education, modeled on the long experience of the Eastern European countries.

There are a variety of games for children and many are board games. Ballesteros (2005) characterized 100 sets worldwide and has divided them into several categories: alquerque (removal of contrary chips), mill (intending to place 3 or 5 pieces in a row), positions, lock and exchanges (try to locate our chips on a given position) mancala (traditional African games, are played with holes in the ground with stones or camel dung), tafl (warlike strategies used two unequal sides in number), go (target is the domain of a particular area or territory larger than the opponent) and career and pursuit (a race on a track reflected on the board that has to be done according to the throw of a die, thus influencing the luck factor).

As such, we can ask why not chess? The choice of chess as an educational game would be based on the following considerations:

1. Chess, unlike other games such as dominoes or Parcheesi, is a game almost entirely supported by logic and mathematics, as well as possessing a degree of imagination and creativity. There is little room for chance, favoring the logical reasoning, which becomes a characteristic element to play properly.

2 Other games based on logic are more limited in their ability to generate ideas, strategies and reasoning: Othello, alquerque, Yote ..., which have the same opportunities but are less visible;

Go ... or Backgammon ... or While, not as popular around the world; Tablut, which is similar

but with rules that change frequently depending on the country; Chinese checkers, Polish ladies

or singles; solo, puzzles…,which obviate the social side of the person.

Thus we find in chess, more than in any other game, the perfect symbiosis of the following characteristics:

a. A set of reasoning and not chance: You need to think before each move.

b. A simple game, but "rich": Chess, contrary to what it may seem, is not exclusively for smart people; anyone with average ability, some dedication, practice, and a great amount of passion, can become a good player.

c. An aesthetically attractive game: knights, bishops, towers, ladies, kings and pawns of two different colours are parts that interact in a chess game. Special attraction causes children chess fantasy and the development of living chess games.

d. A game that allows developing the social aspects of the person: a game of chess is played with another person (although you can also play with computer programs or an electronic board).

e. A cosmopolitan game: Since the FIDE (World Chess Federation) established in 1924

the standardization of the rules of chess; we can talk about a game of great popular acceptance.

The rich amount of educational virtues certainly recommend the use of chess to many professionals of education.

2.3.- Chess materials

A general classification of educational materials for teaching chess would be:

a. Printed Material

Books: available in a wide assortment of Red bibliographic and manipulative for teaching chess material. As a guide, we can mention:

- Books for teaching chess in school. These proposals relate chess with some curricular aspect and offer material in the form of chips to work with students. Some examples are: *Chess in the Classroom* (3 volumes) of Anguix and others (2000); *Chess in School*, F. García (2001); *Teaching Chess in Primary* Segura (2001); *Chess Play and Learn* Prio, Fernández Amigo and Farré (2014); and *Chess* Rial (2003) also devotes a volume for each year of primary school.
- Books for learning chess, ranging from the study of the types of openings until the middle game and the study of game endings. There are also those dedicated to the analysis of games of Grand Masters (GM), as well as tactics and strategies. The two volumes by Kasparov on *My Great Predecessors* would be an example.
- Books to read about chess as recreational reading. *The Flanders Panel* by Arturo Perez Reverte and *Eight* by Katherine Neville would be great examples.

Forms to point plays, that let you play the game to completion.

b. Manipulatives:

Chess board with pieces: They can be wood, plastic, ...

Wall panels with magnetic pieces, ideal for explanations of the first moves and plays more complex in the class group

Clock hands

Digital clock

c. Computer hardware:

1 Databases, as Chessbase, Chess Informant Encyclopaedia of Openings, Encylopedias of Endings, Anthology of combinations or other tools that allow the search for topics with different criteria: per player, per aperture, tournament, year or country. This is a resource widely used by elite players.

2 Programs to learn and play chess as Little Fritz, Chess Dinosuares, Checkmate to the Joker Dog, Deep Junior, Chess Master, Chess Genius and many other, that involve great motivation for learning chess by incorporating multimedia elements such as animation, effects and sounds that make it very dramatic.

3 Electronic boards, as DGT, Kasparov Olimpiade models, Aquamarine, Novag or other, with the same appearance as traditional boards but with electronic chips embedded in each box and each piece, which allow to make moves, and provide advice.

d. Portals to learn and play online for free. Mosst of these have several rooms where our opponent can choose according to our level of play. Some of them are: Chess 21, ajedrecista.com, chesskids chess.com, among others.

3. Using Chess resources for teaching mathematics

A proposal of recreational manipulative teaching materials with chess resources for teaching mathematics is presented in this section. Implementation began in the 2005-2006 academic year in three schools in the Vallès Oriental, two of them located in Parets del Vallès (Lluís Piquer Elementary School and Municipal Patronage Pau Vila Elementary School) and another in Mollet del Vallès (Sant Gervasi State-subsidised School). The materials used were validated at the time (Fernández Amigo, 2006) and subsequently its suitability was ratified (Fernández Amigo, 2008).

3.1 Justification and development of the study

Mathematics has always been considered a difficult and not accessible to all students matter. Some students get overwhelmed with great effort, others find exciting and easy the set of symbols and rules on which they are based, but, for most students, it becomes an insurmountable task to understand, memorize and apply math rules and procedures, leading them to a state of decreasing motivation for the subject. Unfortunately, statistics show us that academic failure in general, and particularly in mathematics, is gradually increasing, especially in the lower stages (Jimeno, 2006). To overcome this situation requires the implementation of more motivating and potentially more educational proposals. In this regard, the use of chess resources is analyzed as a basis for promoting the teaching and learning of mathematics.

On the one hand, research assumes some assumptions such as:

- There is a lack of playful and manipulative materials in the classroom in the Elementary Education for teaching mathematics.
- Chess and methodological elements are an excellent resource.
- It is necessary to improve the motivation of students towards mathematics, incorporating innovative teaching materials and motivators.
- It is necessary to verify the effect that the use of materials has on the development of students' abilities.

Moreover, the review of studies performed (Table 2) make evident (Olias, 1998) that the continued practice of chess helps develop cognitive skills and contributes to improving school performance.

These assumptions lead us to the following objectives:

- To develop and validate educational materials for teaching math using chess resources.
- Analyze their impact on the development of logical reasoning and numeracy.

The **research process** included: a) the construction and validation of educational, recreational manipulative materials, chess resources; (see Fernández Amigo, 2006); b) applying the materials to a sample of students from second grade to see if the application generates satisfaction and significant differences in math performance; (Fernández Amigo, 2008).

The designed materials underwent an initial process of validation by expert judges from different domains: education (4), chess (2), math (1), creation of teaching materials (2), and outdoor activities (1) . Usability, design, implementation, methodology, objectives, content and activities aspects were considered in the validation.

Training materials were applied in three different schools of Vallès Oriental, Catalonya, Spain, two in the town of Parets del Vallès (one public and one municipal) and one in Mollet del Vallès (State-subsidised School). In order to choose the schools these criteria were followed: to currently undergo or previously have undergone chess activities; to have at least two lines per level in order to place a control group and an experimental group of research; and to rely on the agreement of the management teams and teachers. The final sample consisted of 150 students from 2nd year of Elementary education; 75 in the control group and

75 in the experimental group at 25 students per group and school.

The field study included actions such as the following: 1 Pass the tests Intellectual Skills Assessment (EFAI) (Logical Reasoning and Numerical Analysis -R- -N-) at the beginning of the course; 2 Apply the didactic materials to experimental and control groups before and after the use of the materials; 3 Perform statistical analysis using SPS; 4 Develop focus group interviews with the students, teachers and guardians of the experimental groups; 5 Apply questionnaires to the members of the management teams of the schools under study; 6 Get photos, video footage and comments from students during the application of the materials. The materials were applied during the year 2005-06 at the rate of one hour and a half per week in the experimental group in each school, individually or in small groups in rotation, coinciding with the math class.

3.2 Materials validated

Instructional materials used are briefly presented.

1 Dice

5	3	3	9	∞	1

Figure 2: Values of the chess pieces

A die with the silhouette of each chess piece on each side, another given to the value of each piece, according to the graph 3 Launched two dice at a time, add, subtract, compare results, etc ...

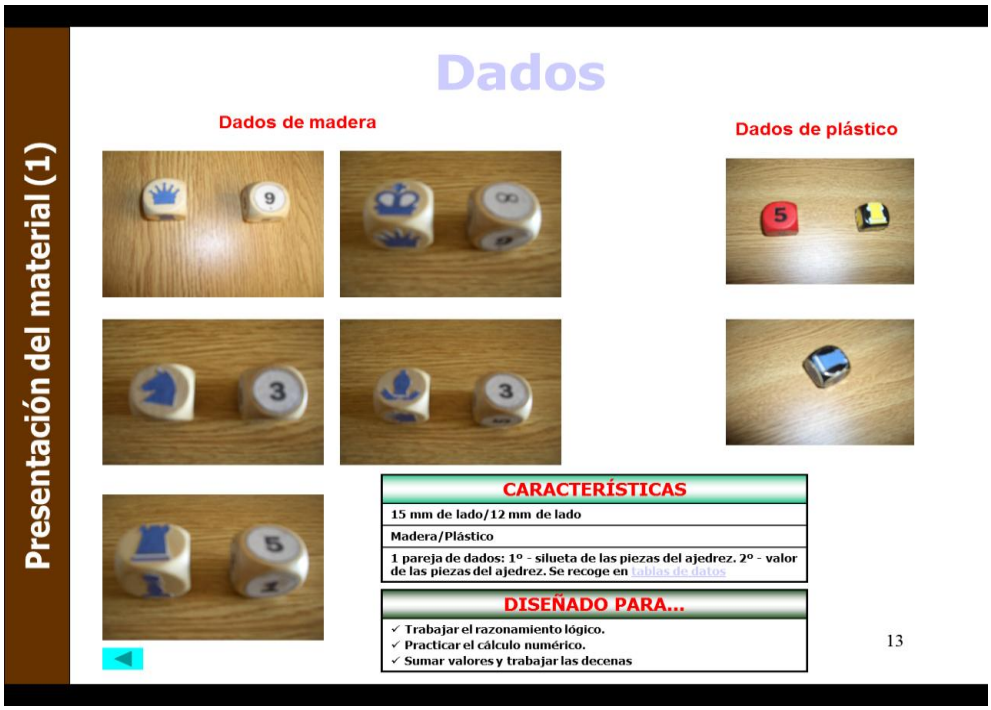

Figure 3: Dice chess

2 Board (horse game)

Players are given a die with the chess pieces printed, a copy of a chess board (10 x 10) laminated with numbers 1 to 100 and a blue, red, green or yellow chip for each player. Each

player will throw the die in turns and move the chips from box to box consecutively with the equivalence of Table 3 (if the die falls in the king's side, no moves are allowed and the players throw again). The winner is the first one to reach the box 100. We say "horse riding and shooting because it touched me" and you can move forward; if it falls in a box marked in red, the player is expected to wait two turns, and if the chip falls inside the black box (No. 98) the player has to start over the game.

Figure 4: Board (horse game)

3 Letters from the deck

Three players play with 24 cards (98 x 57 mm.) Chess in the deck: 12 of each piece, for example kings and queens. 12 cards are given to the Kings player and the 12 other Queen cards to another player. A third player is given three cards with the signs <, = and > spread. Each player throws a card and the player who has the signs <, = and > must place the appropriate sign in the middle of the two cards presented. Other variants can be selected by choosing cards without looking, at adding or subtracting cards, etc...

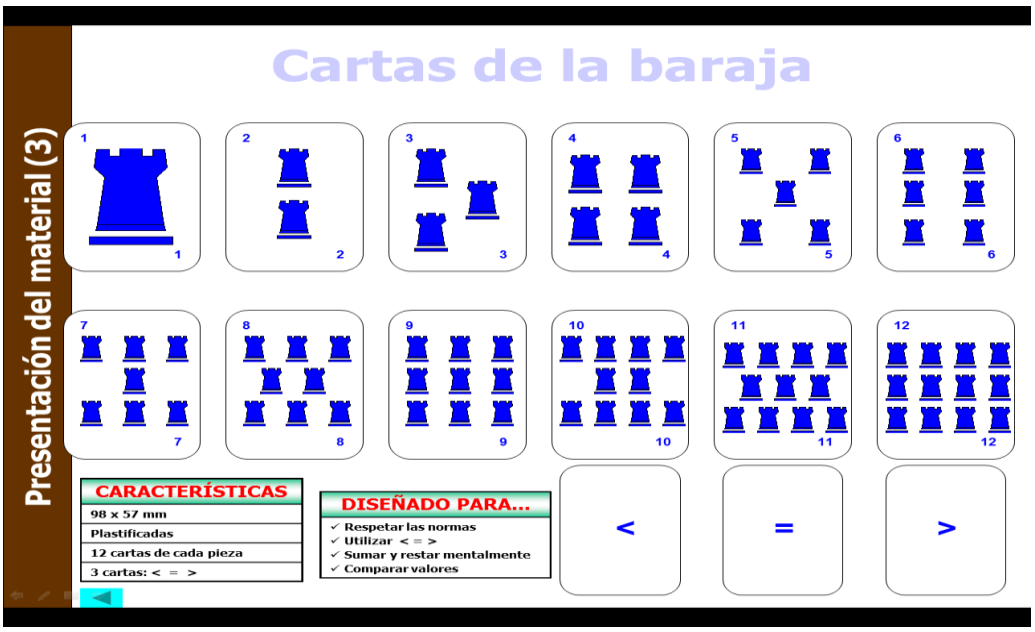

Figure 5: Letters from the deck

4 Domino

It is played with 31 laminated dominoes of chess measuring 98 x 57 mm. The game is the same as traditional dominoes. When a player cannot place a tile, they can replace it by the value of the figure; for example, if a player has put a three, they have no tab and having three points can change it for the horse or the bishop. The conditions of the game are: the winner is the first player to run out of tiles; classification shall be done by adding the points each player has in their hand when the game ends, so the player in the second place will have the fewest points on their tiles and so on.

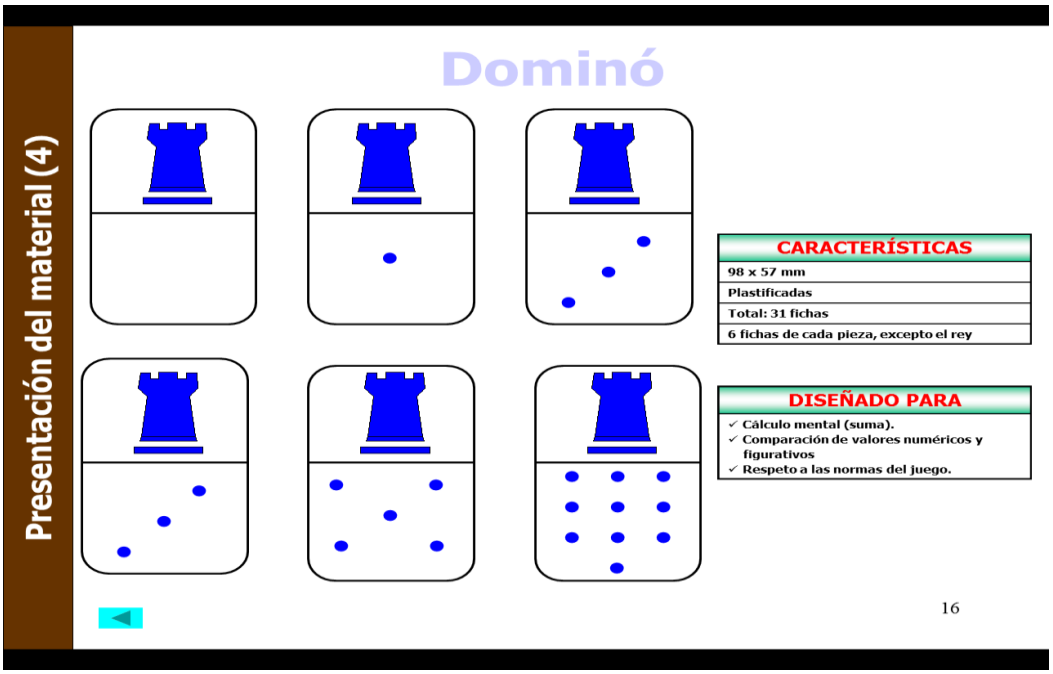

Figure 6: Domino

5. Hexagon

This game consists of a wooden spinning top which sticks to a plastic hexagon. Each sector of the hexagon is occupied by the silhouette of a chess piece. Players score points or compare individual or group results.

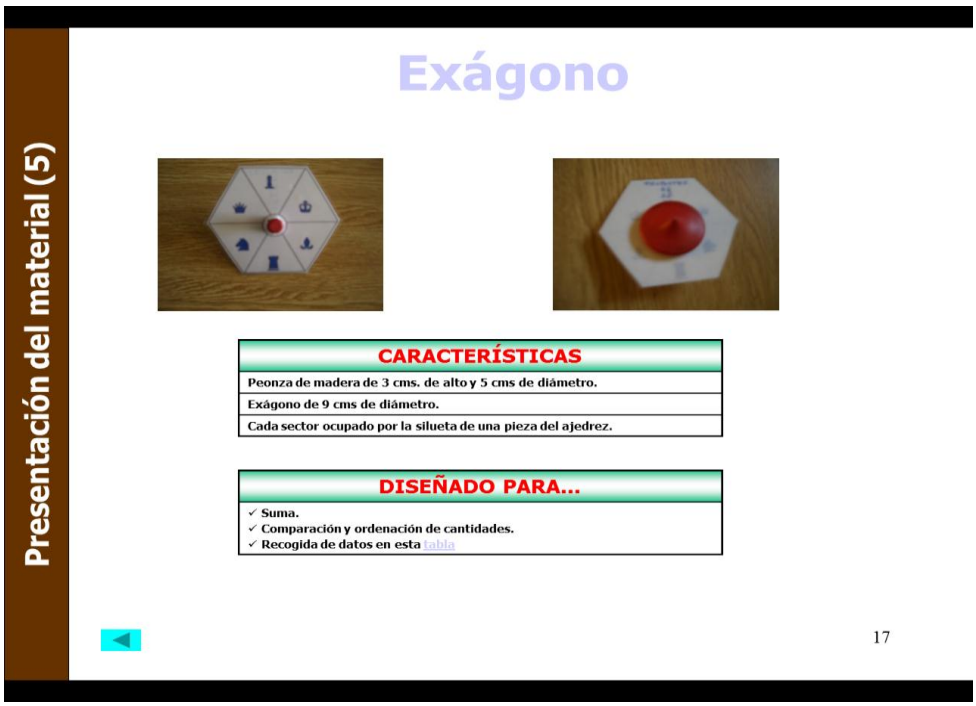

Figure 6: Hexagon

6 Diana

This game consists of an adhesive target (29 cm in diameter) with scores between 10 and 100, which correspond to the scores of the chess pieces but expressed in tens. Each student throws darts or sticky balls from the specified distances, writes, and then they add or subtract and sort the results from the highest to the lowest using the signs <, = and >. In the end, they circle the highest score and draw a square around the lowest score.

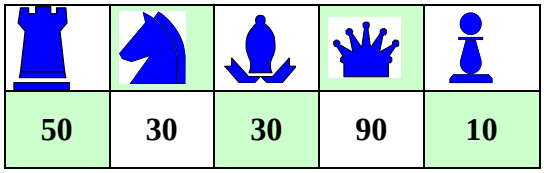

Figure 7: Equivalent scores chess target (tens)

From ⇨	1 m.	1,5 m.	2 m	2,5 m.	3 m.
Release 1					
Release 2					
Release 3					
TOTAL					
Sort highest to lowest scores with < = >					

Table 3: Table of data collection target of chess (additions)

Figure 8: Diana

These materials are linked to the objectives and content contained in Table 4.

MATERIALS	DIDÁCTICS OBJECTIVES	CONTENTS
Dice	▪ Mastering the mechanics of addition ▪ Adding mentally two terms whose figures are less than 20 ▪ Linking the chess pieces and their value and determine whether it is true or false	• Horizontal addition • Tens and units • Mental calculation • Defining relationships between the value of chess pieces
Panel (horse play)	▪ Respecting the rules of the game ▪ Identifying ones, tens and hundreds ▪ Adding mentally values of chess pieces.	• Numbering from 1 to 100 • Units, tens and hundreds • Mental calculation • Addition • Defining relationships between chess pieces and their value
Card deck	▪ Respecting the rules of the game ▪ Correctly using the signs <=> ▪ Adding the numbers from mentally playing chess cards ▪ Properly comparing the value of the cards ▪ Subtracting the values of two cards from the chess card set	• Correct use of <=> • Ones, tens and hundreds • Mental calculation • Sums of summands under 10 • Subtraction • Defining relationships between chess pieces and their value
Dominoes	▪ Respecting the rules of the	• Mental calculation

	game ▪ Adding points and the value of the chess pieces mentally ▪ Comparing figurative numerical values of the cards that the player has in the hand with those on the table	• Addition • Subtraction • Association of chess pieces and their value • Comparison of numerical and figurative values
Hexagon	▪ Correctly using the signs <=> ▪ Adding five addends correctly ▪ Applying the distributive property of addition ▪ Comparing the results of the addition by refining the corresponding signs	• Addition • Association of chess pieces and their value • Comparison of numerical values • Commutative and distributive property of addition
Diana	▪ Correctly using the signs <=> ▪ Adding the figures from the scores ▪ Sorting results in decreasing order and subtracting using appropriate signs ▪ Subtracting the values of the scores	• Addition • Subtraction. • Tens and hundreds • Matching of chess pieces with their value • Ordering from highest to lowest • Units of length

Table 2: Objectives and contents of teaching materials related to teaching

3.3 .- Study Results

The application of the materials allowed us to establish the following general results:

1 Increases in the experimental group (32.05 points) were statistically significantly ($p < 0.05$) higher than those produced in the control group (21.33 points) for the factor N.

2. Increases were 8.16 and 17.25 points in the control and experimental groups respectively for the factor R.

3 The increases obtained in the experimental groups in all the schools were always higher in both factors than the results in the control group.

4 Only significant differences in the increases were found in the second school. Increases in the experimental group were of 23.5 points in the factor N and 31.63 N in factor R.

5 The intervention was significant in the case of girls for both factors (increases in the experimental group, 35.75 and 18.2 points in the factors N and R, respectively); while increases in the experimental group with boys only was higher but did not vary significantly from the results in the control group.

Also, the processes of observation, interviews and focus groups allowed us to point out the following:

a) Total acceptance of materials by students, especially the target and the chess horse.

b) Students felt that the chess resources made learning of mathematics easier.

c) The tutors of the experimental groups felt favorably about the introduction of the materials in math class for its innovative character and the improvement in the quality of education.

d) The tutors of the experimental groups agreed that the application of the material involved an improvement of the methodology in the teaching of mathematics.

e) The tutors of the control groups appreciated positively the application of the pre-test and post-tests, especially the numerical calculation.

f) The members of the management team noticed that the application of the chess resources affected "fairly" or "very much" the mathematical performance.

g) High satisfaction in the use of materials by students as well as positive feedback from their tutors was detected.

The results of the research made evident the viability and the methodological improvement in the teaching of mathematics using recreational manipulative teaching materials with elements of chess. The materials presented promise a positive change in the cognitive, affective and motivational aspects, which suggests that its continued application can be a factor to consider in improving math performance.

The application of materials in various schools also demonstrates that their use affects positively logical reasoning and numeracy as well as user satisfaction. In fact, the differences found in the performance show the positive effects of the applied materials, facilitating their acceptance due to their playful and manipulative character and the incorporation of chess resources.

The use of the materials presented should be considered for the following:

1 Applying them individually or in small groups and on a rotating basis

2 Arranging them in a corner of mathematical chess materials in the classroom

3 Using them as a motivating tool for learning mathematics

4 Aiming to have enough materials for the simultaneous application in multiple groups

Finally, note that the application must be integrated into the curriculum framework and consider its aims and possibilities.

4.- Bibliographical and Internet references

Alsina, Á. (2004). *Desarrollo de competencias matemáticas con recursos lúdico-manipulativos para niños y niñas de 6 a 12 años*. Madrid: Narcea.

Anguix, J. et al. (2000). *Ajedrez en el aula 1, 2 y 3*. Valencia: Evajedrez

Ballesteros, S. (2005). *Juegos de mesa del mundo*. Madrid: CCS.

Batllori, J. (2001*). Juegos para entrenar el cerebro. Desarrollo de habilidades cognitivas y sociales*. Madrid: Narcea.

Bergasa, J. et al. (1996). *Materiales didácticos. Matemáticas*. Navarra: Fondo de Publicaciones del Gobierno.

Calderero, J. F. (2005). *Que me pasa con las matemáticas*. Madrid: El rompecabezas.

Carlavilla, J. L. y Marín, M. (2001). *La educación matemática en el 2000.* Cuenca: Ediciones de la Universidad de Castilla-La Mancha.

Carrillo, E. y Hernan, F. (1998). *Recursos en el aula de matemáticas*. Madrid: Síntesis.

Cascallana, M. T. (1993). *Iniciación a la matemática. Materiales y recursos didácticos*. Madrid: Santillana.

CIDE – Centro de Investigación y Documentación Educativa- (1998). *Juegos y materiales manipulativos como dinamizadores del aprendizaje en matemáticas*. Madrid: Centro de Publicaciones. Ministerio de Educación y Cultura.

Corbalán, F. (1994). *Juegos matemáticos para Secundaria y Bachillerato*. Madrid: Síntesis.

De Guzmán, M. (1984). *Cuentos con cuentas*. Barcelona: Labor.

Fernández Amigo, J. (1992). *Ajedrez a tope*. *Cuadernos de Pedagogía*, 204, 40-42.

Fernández Amigo, J. (2002 a). *Ajedrez para enseñar valores*. *Cuadernos Técnicos: El*

ajedrez un juego educativo, 5. Patronato Municipal de Deportes. Palencia, 32-40.

Fernández Amigo, J. (2002 b). *El ajedrez integrado en el currículum. Peón de Rey*, 140, 30-32.

Fernández Amigo, J. (2002 c). *El ajedrez, señal de identidad*. *Cuadernos de Pedagogía*, 313, 29-33.

Fernández Amigo, J. (2003). *Implantación del ajedrez en un centro de Primaria*. *Organización y Gestión de Centros educativos.* Puesta al día 29, 73-99.

Fernández Amigo, J.; Rodríguez, J. R. y Sánchez, Á. (2004). *Ajedrez transversal*. *Aula de Innovación Educativa*, 130, 65-68.

Fernández Amigo, J. (2006). *Construcción y validación de material didáctico para la enseñanza de las matemáticas utilizando recursos de ajedrez*. Trabajo de investigación. Barcelona: Universidad Autónoma de Barcelona.

Fernández Amigo, J. (2008). *Utilización de material didáctico con recursos de ajedrez para la enseñanza de las matemáticas. Estudio de sus efectos sobre una muestra de alumnos de segundo de primaria*. Tesis doctoral. Barcelona: Universidad Autónoma de Barcelona.

Ferrero, L. (1991). *El juego y la matemática*. Madrid: La Muralla.

Gairín, J. (1987). *Las actitudes en educación. Un estudio sobre educación matemática*. Barcelona: PPU.

Gairín, J.Mª y Corbalán, F. (1988). *Juegos en clase de matemáticas*. *Cuadernos de Pedagogía*, 160, 50-51.

Gairín, J.Mª.y Muñoz, J.M. (2006). *Moviendo fichas hacia el pensamiento matemático*. *Suma*, 51, 15-21.

García, A. (2001). *El ajedrez en la escuela. Para niños de 8 a 10 años*. Barcelona:Paidotribo.

García, F. (2001). *Educando desde el ajedrez*. Barcelona: Paidotribo.

Gardner, M. (1991). El ahorcamiento inesperado y otros entretenimientos matemáticos.

Madrid: Alianza.

Gimeno, J. (1991). *Los materiales y la enseñanza*. *Cuadernos de Pedagogía*, 194, 10-15.

Jimeno, M. (2006). *¿Por qué las niñas y los niños no aprenden matemáticas?*. Barcelona: Octaedro.

Laplaza, J. (1999), en http://www.laplaza.org.ar (consulta 10/12/2009)

Lobo, J.A. y Martín del Buey, F. (1999). *Los efectos del transfer en niños que juegan al ajedrez*. Memoria de investigación. Doctorado. Bienio 1997-1999. Oviedo: Universidad de Oviedo. Departamento de Psicología.

Martín del Buey, F. (1997). *El ajedrez como asignatura. Enfoque interdisciplinar y de transferencia de conocimientos*. (3º de Primaria, curso 95-96). Oviedo: Facultad de Psicología.

Muñiz, C. (1995). *Experiencias didácticas en torno al ajedrez*. I Encuentro de monitores de ajedrez. Oviedo: Escuela de Magisterio.

Olías, J.Mª (1998): *Desarrollar la inteligencia a través del ajedrez*. Madrid: Ediciones Palabra.

Palacián, E..; Sancho, J. (2001). *Actas de las X Jornadas para el aprendizaje y*

enseñanza del as matemáticas. Zaragoza: ICE Universidad.

Parcerisa, A. (1999. *Materiales curriculares. Cómo elaborarlos, seleccionarlos y usarlos*. Barcelona: Graó.

Parcerisa, A. et al. (2005*). Materiales para la docencia universitaria*. Barcelona: Octaedro/ICE-UB.

Prió, J.. et al. (2003ª). *Juega y aprende 1 y 2*. Balaguer. Lleida: Balàgium editors.

Prió, J.; Fernández Amigo J. y Farré, I (2014). *Juega y aprende 3 y 4*. Balaguer. Lleida: Balàgium editors.

Prió, J. et al. (2003b). *Escacs per a tothom. Iniciació 1 i 2*. Balaguer. Lleida: Balàgium editors.

Rodríguez, J. (1996). *Influencia del ajedrez como actividad excátedra para mejorar el rendimiento académico en alumnos de la segunda etapa de Educación Básica en la Unidad Educativa Estatal "Piloncito"*. Tesis doctoral. Caracas. Venezuela: Universidad Nacional Abierta.

Rodríguez, J. R. (2004). *Ajedrez y educación. Un enfoque transversal*. Trabajo de investigación. Universidad de Oviedo. No publicado.

Rial, J. C. y Páramos, R. (2003). *Ajedrez (primero, segundo y tercer grados).* Vigo: JRedition.

Sarramona, J. (1992). *Els recursos pedagògics materials*. *Crònica d'Ensenyament*, 50, 39-41

Segura, A. (2001). *La enseñanza del ajedrez en Primaria*. Barcelona: Paidotribo.

UNESCO (1995), http://iesbcfra.educa.aragon.es/Dmates/33ajescu.htm (consulta 10/09/2009)

UNESCO (1998), http://enlaces.ucv.cl/pags/area_acad/manual2/site/docs/ppt/materiales%20curriculares.ppt (consulta 10/09/2009)

Vila, A. y Callejo, M. L. (2004). *Matemáticas para aprender a pensar*. Madrid: Narcea.

Zabala, A. (1990). *Materiales curriculares*, en Mauri, Tomás, et al.: *El currículum en el centro educativo*. Barcelona: ICE de la Universidad de Barcelona/Horsori. *Cuadernos de Educación*, 125-167.

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