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PLAY, PUZZLES AND CREATIVITY: LEARNING ENGINES FOR THE KNOWLEDGE SOCIETY

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PLAY, PUZZLES AND CREATIVITY: LEARNING ENGINES FOR THE KNOWLEDGE SOCIETY

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> Information and knowledge have limited value in and of themselves, unless they are used creatively. Success in tomorrow's world will not have a primordial base in information and not even in knowledge, but in the way we make use of them—in creativity.
>
> Forum on the next generation, 1999. [*1*]

ABSTRACT

This work centers on the three basic elements for participating in the knowledge society: play, puzzles, and creativity. Each of these carries with it vital ingredients for the development of the potential of individuals and the groups to which they belong, within a society that demands discipline, tenacity, initiative, flexibility, and the capacity to innovate and adapt on the part of each of its members and over the complete span of life. The document analyzes some of the challenges imposed by the knowledge society on the education sector, thus framing the function we hope to fulfill for different agents of the process. Within this frame of reference, the discussion centers on creativity and associated concepts, such as lateral and divergent thinking, showing them as indispensable complements to vertical and convergent thinking. Play and puzzles are the focal point of the pedagogical discussion. We analyze concepts and unassociated concepts, trying to find the point where we can create an educational advantage, and emphasize those elements that can become sparks of action in engines for permanent learning and instill them in each person or group of people as something they will want to use. The work closes by reviewing some of the driving ideas of the Ludomatica[1] project and reflecting on its main elements from the perspective of play, puzzles, and creativity.

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[1] *Ludomática: playful, creative, collaborative, and interactive environments* is an innovative educational project being developed together with the University of the Andes, through the Laboratory of Investigation and Development of Informatics in Education (UNIANDES-LIDIE) and the Rafael Pombo Foundation (FURAPO). It takes place in day care institutions (informal education) and in primary schools attended by boys and girls of primary school age (7 to 12 years) and who live in marginalized areas, urban or rural, or who are at risk. The pilot stage in day care institutions has been cofinanced by Colciencias and ICBF, its expansion to formal education by the secretaries of education (Bolivar, Capital District), interested groups and organizations (UNIR old Caldas, CAB in Bolivar). We have also counted on a donation from Microsoft Corporation. For additional information on the project see: http://lidie.uniandes.edu.co/ludomatica

INTRODUCTION

Many people associate play, puzzles, and creativity with preschool education: nobody thinks of preschool education without those three components coming to mind. But how often do we evoke those ideas when discussing education beyond infancy, or lifelong learning, and consider that learning, more than teaching, is what makes education life itself, rather than a simple preparation for life? Why is it that, after leaving preschool, we gradually lose the association between education and the basic elements of childhood development? Is it that once we are adults, we consider play to be something infantile or belonging only to the world of entertainment, puzzles as simple curiosities or challenges for solving, and creativity as a gift had only by those most sensitive to art, lovers of poetry or those involved in design?

Independent of the answers one has for each of these questions, it is certain that they will disquiet more than one educator, parent, business person or leader, when they reflect on what it takes to live in the present world and confirm that the education paradigm is predominantly transmissive and that it privileges the knowledge and use of converging authorities in problem solving. Despite the present explosion of information (today more information is created, organized, and shared per minute than could be systematized in months or years a few centuries ago) and its adoption in ubiquitous forms, the mass communications media and the Internet bring facts, news, chronicles, or opinion as well as offering whatever is required to increase depth in each subject are spread at a speed not imaginable a century ago. Educational organizations continue to focus on the acquisition of knowledge and on the application of rules. They lose sight of how in a constantly changing world such as the present, the use of known knowledge is insufficient for getting ahead. Flexibility and innovation are the qualities that procure human and creative development and make people and organizations successful, aspects which make a difference given the changing conditions of the environment.

The hope is that once creativity, play, and puzzles are revalued within the permanent education process, it will lead to the creation of learning environments within which it will be possible to discover the meaning of the knowledge society. This will allow learners to take advantage of the potential of both the conventional and the novel, where both digital and non-digital technologies complement one another in the search of possibilities for our development personally, as a community, and as a species. It is hoped that play, puzzles, and creativity will become motors for learning throughout life and, in integrated learning environments, as a medium for freeing human potential.

THE EDUCATION PARADIGM CHANGE AND THE REQUIREMENTS OF THE KNOWLEDGE SOCIETY

The paradigm shift in education is a growing uproar that accompanies the old longing for rethinking education, transitioning from a vertical scheme – from those who know to those who do not, toward a horizontal one in which all with common interests for learning participate, without regard to age, condition, or gender, and where the continuous re-education of who we are in this business may be an intrinsic condition [2].

This old idea has gathered a lot of strength with the advent of the knowledge society and the information age. As I have said on other occasions [3] they present enormous challenges to educators due to the ubiquitous proliferation of information and the overcoming of many special and temporal barriers for accessing that information. Likewise, the destruction of barriers that comes with this proliferation is itself part of the change for human development and for competitiveness, where education is no longer a synonym of schooling. Education is a permanent requirement for living within our era. Because of this, the preparation for participating in the

knowledge society should center on those processes which are critical for life-long learning, such as observation and listening, the framing and solving of problems, creativity and divergent thinking, critical thinking, and the disposition for cooperative and group work.

I have also indicated [*ibid*] that just as the knowledge society presents great challenges to education, it also offers great opportunities for improving education. New media permit high levels of interactivity and connectivity. Computers and communication networks can be integrated and amplify the power of classical expositional media --such as books, videos, or television--, or of active or interactive media --such as different types of games, simulation, exploration of physical surroundings, with all their cultural and scientific richness. With the aid of technology it is possible to take advantage of the body and its potential for expression, just as interpersonal relationships whether present or distance. With them it is possible to make together learning environments that favor the development of critical skills beyond reading and writing, such as communicating with other people, appreciating differences, being capable of putting together a group and collaboratively solve problems of diverse types. The arsenal of media we can resort to in this era, used with an educational purpose and within contexts meaningful for learners, affords experiences that are interesting, exciting, and challenging, and experiences that generate or further elaborate knowledge.

VISIONS AND PROPOSALS FOR CHANGING THE PARADIGM

The dynamics of these forces, which promote and sustain the paradigm shift on the education sector, appear in many ways depending on the perspective from which one looks at them.

From a socio-economic point of view, for example, there is a growing need to depend on people at every level, beyond simply following instructions or knowing how to do something--qualities which were highly desirable in the industrial age. Nowadays it is crucial to find out opportunities and possibilities for action where others do not, to use information for creating ideas that make a difference, to restructure old models or to generate new frameworks and dynamically to evaluate alternatives in light of the changing needs of the environment and the actual possibilities of the different structural mechanisms. Whenever one speaks of changing the attitude with which one approaches phenomena or problems, he or she stops merely following instructions and assumes the role of situation analyst and problem solver.

From the psychological perspective, there is a growing appreciation of principles that go beyond instruction (processes controlled by the teacher) and privilege the learning (processes controlled by the learner). Programming of educational activities in pursuit of declared objectives, gradual practice of skills and dexterity, external reinforcement of desired performance, and other behavioristic educational ideas, have enriched educational praxis. In parallel, there is recognition of the importance of knowing about the learners and their vital field. It is valued to rescue and to care of self-esteem, to recognize and take advantage of intrinsic motivation. Inquisitive exploration of learning environments that are meaningful to learners and relevant to what they want to learn is a critical issue. Appreciation of learner's differences and recognition of the need to make explicit tacit knowledge has helped promoting the "AHA!" moment. This eclectic combination of psychological principals for promoting learning follows not only the re-valuing of premises for designing learning environments (changing control from the teacher to the learner and vice versa), but also the necessity for following the aforementioned requirements necessary for the knowledge society.

From the perspective of didactic strategy [4] there is cause for concern because diverse disciplines are integrated and the teachers and students interact in an interdisciplinary way in realizing the work and projects of learning. This idea centers educational processes on phenomena or problems, rather than on content; upon breaking the compartmentalized

monopolies of the disciplines; and upon obtaining collaborative work on integrated processes of teaching and learning. Putting this in practice demands the generating and participating in projects of collaborative learning, local and global, which serve as the base for curricular integration, such as for the integration of educational wisdom and cultures from among participants. Likewise, it requires improving teacher skills for making collaborative work in their tasks and those of their students, such as using informatics for supporting those tasks. Similarly, it is required to develop among educators criteria and skill for integrated use of learning resources, both within class and outside of it, in such a way that students take advantage of the multiple paths that exist for arriving at knowledge.

THE NECESITY FOR COMPLEMENTARY PERSPECTIVES

The above-mentioned initiatives demonstrate considerable advance in the fundamentals, orientation, and instrumentation of what can be called learning environments in the knowledge society. However, there are various critical vacuums that require filling, in what has traditionally been called the creative side of the learning process, which is normally left to teacher inspiration or student initiative. For that reason, we dedicate the following sections to exploring what comes with this domain and the contributions of play and puzzles to the forging of persons with initiative and flexibility, developing at the same time the discipline and tenacity necessary for achieving the capacity for innovation and adaptation.

CREATIVITY AND LEARNING ENVIRONMENTS

In her article on *Creativity and Teachers* [5, p.175] María Emilia Arciniegas shows that creativity is an aspect of life that affects both the intellectual and spiritual faculties and that demands, from a psychological point of view, continuous processes of modification and adaptation of self and environment, generally committing to a new way of being and thinking. It's dialectic, as to achieve an ideal requires modifying or breaking deeper structures than those that prevent the achievement of self-development. Creativity expresses the discovery and production of something novel or original, outside of the traditional, in an individual who is determined and creative.

This combination of intellectual and spiritual faculties that she distinguishes make it possible for two complementary tendencies to fit within the concept, one related to scientific activity and the other with artistic activity, which permit differentiating between *having creativity (being a creator)* and *being creative*. According to Jaime Parra [6 cited in 5, p.179] *having creativity* is having the capacity to establish unusual relationships and associations, to solve problems, to identify diverse alternatives, the development of analogical thinking, fluency, and originality. *Being creative* has to do with the sources of inspiration, the brilliancy of ideas, spontaneity, freedom of spirit, psychological security, motivation, familiar environments, and humor,.

The two perspectives mentioned refer to what is commonly called creativity and genius. Both include reordering of the mental models that we have, but while the creativity orders information in a permanent way, genius is of a transient character, something like a spark. A joke[2], for example, is a demonstration of genius, but design or composition are creative activities. *Being creative* is the fruit of inspiration and genius, *having creativity* is something that can be cultivated and developed. Both are innate abilities that have much in common but are not the

[2] Just for laughs: I don't know if I've told you this joke, said one. Is it funny, asked the other. Of course, replied the first. Hmm . . . then you haven't told me it, said the second.

same, that require sensitivity and curiosity, that bring with them mental tickling and sudden discernment, but that are of a different nature.

BASE CONDITIONS FOR CREATIVITY

As Juan Carlos Negret [7], shows, Creativity is preceded by a state of initial disorder, of discontent, of feeling poorly. Because of that tone of dissatisfaction that something is missing, it is the opposite of accommodating oneself, or of being always in the same place or the same situation. Creativity and laziness repel one another.

On the other hand, creativity and persistence go together. A creative person insists on coming back again and again, on trying another time. To be creative is to convert every failure or error into an impulse.

As this author says, creativity, or the ability to combine, to discover relationships that are not evident, to find different similarities and similar differences, is the starting point of any initiative that has a future. To be creative is to glimpse possibilities, it is finding ways—there are always some—out of any problem despite any difficulties. Creative people believe without being gullible and mistrust without being skeptical.

LEARNING ENVIRONMENTS FOR CREATIVITY

What can be said about learning environments[3] in relation to creativity? what scholastic organization, medium of communication, family, work, or environment in which we move and in which we learn, continuously propitiate this restlessness and tenacity that characterize the creator?

It seems that the Colombian school system the school is organized in such a way as to dispel the curiosity and capacity for amazement of boys and girls [8 cited in 5, p. 180]. It is as if the reigning educational paradigm is opposed to the development of children's innate abilities. It will kill curiosity and the ability to speculate, to wonder and fantasize, to leave loose the reins of imagination and to generate ideas that can bring us to new ideas and better worlds for everyone.

Can we simply blame the school? Could it be that this quarter hour of our life needs to be recovered as the enabler of creativity? I think that achieving this is in the hands of educators, that it is necessary to convert schools into generators of enabling environments. However, that is not the only thing that needs to be changed.

It seems there is also a focus on paradigmatic paralysis in schools. This problem can be found in many human organizations, beginning with the family and the school, where the daily messages such as "don't do that", "do it this way", "do it this way and don't argue about it", "I was going to do it, but . . ." are everywhere, these are obstacles to creativity that Negret [7] identifies. Every one of these expressions brings with it mental schemes that are difficult to break, but, if they are not taken for granted, and if there is the desire to overcome them, it's possible to make room for novel approximations of the phenomena that interest us.

Studies realized by the Next Generation Forum [1] show that children today spend nearly 85% of their time, from birth to age sixteen, outside the classroom and, therefore, should account for multiple learning environments, formal and informal, when speaking of creating favorable conditions for the development of creativity. It is important to carefully identify these

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[3] Note: creativity is not taught but learned and developed; that is why it is necessary to create appropriate environments.

conditions and invest energy in developing the sensitivity and ability to make them a reality across the different dimensions of our lives.

CREATIVITY AND LATERAL THINKING

What Barker calls paradigmatic paralysis can well be related with what De Bono [9] identifies as the ability our minds have for creating and using information models and the fixation that can come with them when used without a critical spirit.

De Bono [9, cap. 1] says that aside from experience, our minds create models for their own identification and use. More than a simple reflection of external realities, these models constitute a reaction of the mind against those realities, they are an efficient way to identify and use information, whether or not they are correct. Memorized information is susceptible to restructuring when passed from one arrangement to another, thanks to genius or perspicacity[4] which make possible for these models to be quickly identified and usefully employed. These, which are the primary qualities of models, come with disadvantages, such as tending to become more rigid, thus becoming a growing demand on attention, with a tendency toward concentration in the sense that everything that resembles a standard model is perceived to be a real part of it. On the other hand, sometimes it is difficult to choose between one model and another. However, when one has make a decision, one tends to accept as one as valid and discard the other completely, which results in a polarization, going from one extreme to another, without maintaining equilibrium between them. To overcome the difficulty of restructuring models of ideas in response to new information, this author proposes applying techniques of lateral (or creative) thinking.

To explain this concept he contrasts it to vertical (or logical) thinking, which most people consider the only effective way of thinking. The table on the next page offers a synthesis of both concepts. It is important that these two forms of thinking complement one another and combine to make thinking a multifaceted act. Lateral thinking is useful for generating ideas and new ways of seeing things. It makes sense to apply it in the creative phase of ideas and new focuses on problems and situations. Vertical thinking is necessary for the subsequent examination and practical application, which corresponds to the selection and final application of what was generated.

Understanding the essence of lateral thinking, of divergence, it is worth wondering what practical application it has when discussing the creation of learning environments for different domains. How can one put in practice, in a way that it becomes an element that sparks creative processes in both formal and informal learning environments?

There is no immediate answer. More than being rules for application, they are attitudes toward the phenomena and points of view they incorporate. It is not sufficient to know that they exist, it is necessary to live them and use them to break the schemes of thinking and action that we are bound by inertia to use. De Bono proposes a variety of generic techniques that can help lateral thinking, the review of which we leave to the reader's curiosity, whom, as Gloria Bejarano [10] shows, should keep in mind that as long as they become recipes, they will be going against the essence of creativity.

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[4] De Bono understands *Perspicacity* to be the profound and clear internal vision of a theme or of a part of it. He considers it the only efficient way to change concepts. He offers the change of existing information models and subsequent structuring of a different order.

Table 1. Contrast between vertical (logical) thinking and lateral (creative) thinking [9, cap. 2]

Vertical (logical) thinking	Lateral (creative) thinking
Selective. Primarily it has to do with logical correction of the chaining between ideas. It selects the most promising focus for a solution.	Creative. Its essence is the effectiveness of the conclusions. Look for new focuses and explore all their possibilities.
One must always move in a direction for which there is a solution. Uses concrete techniques as a focus. The vertical thinker knows what he or she seeks.	Can move in any direction, digresses around experiments, models, ideas, etc. Through those digressions a direction is generated. The lateral thinker searches, but does not know for what until finding it.
Based on sequences of ideas. Each step has to be correct, as this is a condition for the solution to be correct.	It's acceptable to take jumps. Ideas don't have to follow a determined order, nor do they have to be correct. The only condition is that the solution is correct.
The categories, classifications, and formalities are of a permanent nature, ideas can be used only if they are indicated with distinctions that permit their identification. Based on the inalterable character of symbols.	The formalities are changed as necessary according to the context, which changes according to the different focuses. Employs fluidity of meaning, in an analogical pattern.
Tries to arrive at a solution. Offers at least a minimal solution.	Does not necessarily guarantee a solution, simply increases the probability of arriving at a better solution.
The information is used according to its intrinsic value, to eventually arrive at a solution that is fits into existing models.	The information is not used as an end in itself, but rather as a medium for provoking a separation of models and the restructuring of new ideas.

Towards the practical effects of this work, I want to emphasize the following simple ideas proposed by Arciniegas [5, p.194-197] as strategies for encouraging creativity in learning environments.

- Permit and generate significant, high level questions that open paths to creation that are relevant to the environment, and that permit contact with the reality of student and teacher, in consonance with their interests, which are expressed as real or fictitious facts. For example, what would happen if the sun stopped shining? What would a fantastic city be like?
- Release divergence within logical relations such as cause-effect, cause-consequence, action-reaction, classification, and organizing.
- Provide incentive for analogical thinking: discovering the unknown from the known, utilizing strategies such as similarities, comparison that generates metaphors and similes, paraphrasing and personification, parables, schemes, corporal identification, the analogical search of relations, etc. For example, how are a football, a basket, a jacket, a dog, and a hat similar and different?

- Stimulate the use of guessing games, puzzles, deciphering, riddles or of representations within which a message can be discovered. For example, "they say I'm King but I have no kingdom; they say I am blonde but I have no hair; they affirm that I walk but do not shake; I fix watches without being a watchmaker" (*Cuclí-Cuclí* Magazine).
- Develop habits such as the detailed observation of objects or the investigation of personal doubts, accompanied by living an experience or a significant process. For example according to Arciniegas [5*, p.200*] one of the strategies that Victor Lowenfield and Labert Brittain recommend in their book *The Development of Creative Ability*, is, articulating the learning of non-artistic subjects with artistic expression of what has been learned.
- Cultivate intuition and common sense are another way of approaching knowledge of reality. For example, ask students what they could do with a brick, a piece of paper, and a can of preserves. Later, reflect on the industrial procedures that are required to manufacture them and their ecological effects on the environment.

PLAY AND PUZZLES AS SPARKS FOR CREATIVITY

It is clear that to develop creativity in all of its dimensions, scientific and artistic, it is necessary to eliminate restraints, and to release the children we all carry within. We must leave them free to explore, digress, dream, make and correct mistakes, to see the world in multiple ways and, at the same time, refine our capacity for confronting problems, our motives for valuing alternate solutions and to validate these solutions' convenience and sufficiency. It is also clear that being creative is something that demands determination, tenacity, and persistence in the search for answers to the doubts that assail us.

The thesis of this work is that play-play and puzzles can be sparks for these processes in all learning environments, not only in early education, where it is almost a basic truth. It does not claim that without play and puzzles it is impossible to develop creativity. Creativity is an intrinsic part of being human, a vital part of the self. For everyone to have creative potential one cannot infer that everyone can make use of the same things in the same way, because it is precisely those barriers which I mentioned earlier that inhibit and prevent. To support this thesis it is necessary to clarify what the terms mean and, building on that base, find the ways to articulate them with the principals of lateral thinking, that are intimately tied to creativity.

PLAY-PLAY AND CREATIVITY

Some of the ideas taken from the conceptual framework of Ludomatica [11] may help us understand the relation between play-play and creativity and serve in counterpoint to other ideas of interest to us:

> Play is a space of uncertainty, difficulty, and, of challenge and creativity, that invites participation in the collective construction of alternatives [*ibid.,* p. 27].
>
> Those who enter play find a world of autonomy, decision, and risk. To survive in play it is necessary to make use of their life experience and knowledge, and resort to instinct and perspicacity at the moment of inquiry and the search [*ibid*., p.29].
>
> Play makes evident abilities that are normally hidden. The basic uncertainty of play demands mental alertness and active use of the senses [*ibid*., p. 32].
>
> Play demands the creation of an environment of mutual recognition and confidence between the players [*ibid.,* p. 32].

> Through play we learn to make decisions and to develop strategies in conflicting situations. Play makes it possible for us to learn to affirm ourselves in competition and in what we attempt on different levels [*ibid*., p. 43].
>
> Play, absolute and passionate play, is that which makes us human, saves us from solitude, and permits us harmony in the world [*ibid*., p.32].

The work of the Rafael Pombo Foundation offers a similar perspective, molded after a recent study of workshops of creative expression [12]. It says:

> In the case of the workshops it is not enough to have the basic conditions, it is necessary that they relate to the play. But what kind of play? The English literature differentiates between play with rules, called a "game" and free or improvised play, called "play". It is evident that the play described there is free and improvised play. This notion, in agreement with Winnicott [13, p. 49], is intrinsic to every human activity that has to do with spontaneity and originality, and is found at the source of all cultural products.

Ideas such as these tacitly contain something that is very clear in Ludomatica: play-play is one thing and play for training or controlling is another thing. This idea of play-play is contrasted to other meanings that are used in the world of education, just as Bejarano [11 above] says:

> The action of play has nothing to do with the future, play is not preparation for anything, play is to do what one does within its basic meaning, without considerations that might negate its legitimacy" [11 above, p.30, citing 14, p.144].
>
> The only play which has no "visa" for entering [within the creative process] is domestic play that has been "trained" for teaching [11 above, p.32]. On recognizing the pedagogical vocation of play, the educational world has made confusing the privileged role it has in relation to our lives, as a generator of new knowledge in place of being a basic tool for teaching, or, what is more dangerous, as a way of camouflaging teaching, praised because it is a way of making students "learn without realizing" that they are learning. When play becomes a justification of our actions, it loses its very nature and no longer makes sense as a space for creation [11 above, p.31]
>
> Play that has been diminished and dissected, utilized and denied, is the root of a culture based on the necessity to control, to achieve success, or to compete for results. This is the source of the utilitarian and soothing character of play in our society. The joy of play which comes from the excitement of the unknown, the tension and the effort, has been exchanged for a toy pleasure, insignificant and devalued as play that has been made required: "Pleasure in place of pleasure" [11 above, p.30].

Play-play complies with what Walton identifies as a characteristic of child's play, to parody what Kant affirmed of art: "it is a purpose without an end", something made that only makes itself. From the moment, in whatever activity becomes utilitarian and subordinated as the means to an end, it loses the attraction and character of child's play [15 cited in 16].

Here play-play refers to play as a fundamental element for developing the CREATOR within all of us. We resort to puzzles to promote the capacity that Parra [6] calls HAVING CREATIVITY, our ability to solve problems.

THE NATURE OF PLAY

Now that we have established the meaning (play-play) that we want to give to play, it is worth exploring the main principles of the concept, those that reaffirm what we've laid out in relation to what play is and is not. Consultation with various studies on this theme are helpful:

Huizinga [17, p.26] takes the position that play is a free action, executed as such and experienced as something situated outside of normal life, but in spite of that, something that can completely absorb the player even without a material interest and without obtaining any benefit, which is executed within a determined time and place, which is developed within order and subject to rules and which gives birth to associations that tend to surround themselves with mystery or costumes for detaching oneself from the actual world.

Beyond this proposition, Caillois details the following components of play as an activity [18, p.37]:

1. *Free*: the player cannot be obligated or else the play loses its nature as an attractive and happy diversion.
2. *Separate*: circumscribed within precise limits of space and time determined in advance.
3. *Uncertain*: its development cannot be predetermined, nor the results given beforehand.
4. *Unproductive*: it creates neither benefits, nor wealth, nor anything new of any kind.
5. *Organized*: subject to conventions that suspend normal laws and momentarily provides new rules that are the only ones that count.
6. *Fictitious*: Accompanied by a specific consciousness of a secondary reality or frank unreality in comparison to normal life.

Garvey [19, p.19], indicates that all play requires that players understand that what is happening is not what it appears to be and that this non-literal attitude is what permits play to present softened consequences, what allows play to be play. The broadly accepted descriptive characteristics of play are as follows:

1. Play is *pleasing*, fun. Even when not accompanied by signs of joy, it is seen as positive because of what it achieves.
2. Play has *no goals or extrinsic ends*. Its motivations are intrinsic and are not found to serve other objectives. In fact, it is more an enjoyment of the medium than an effort directed toward a particular end. In productive terms it is inherently unproductive.
3. Play is spontaneous and voluntary. It is not obligatory but freely chosen by those who do it.
4. Play implies a certain active participation on the part of the player. In this sense it is different than entertainment, which can share the above qualities but not this one.
5. Play retains certain systematic connections with things that are not play, for example with creativity, problem solving, language development, the development of social roles, and other numerous social and cognitive phenomena.

THE EDUCATIONAL VALUE OF PLAY

A recent work by Rosa Mercedes Reyes-Navia on *Play and Processes of Development and Socialization* [16] makes clear that for cognitive psychologists, play has been one of the most important themes among those relating to the development of human potential. The following synthesis points out the contributions from different perspectives:

For Vygotsky [20, cited in 13], play in children is naturally transitional. It is a state between the purely situational limitations of early infancy and adult thinking [*ibid*, pp. 56]. The importance of play for children roots itself primarily in the dynamism that it generates in developmental processes. Play permits children to live extreme experiences, such as those that favor subordination to many rules. This brought Vygotsky to consider play a zone of proximal development[5]: "a child is always above his average age, above his daily behavior: in play it is as if he were a head taller than he really is." [20, p.156, cited in 13, p.58].

For Piaget there are various classes of infant play, associated with the stages of development. (1) Exercise games (0 to 2 years, preverbal development phase), consist of putting into action behaviors done without any goal other than the intrinsic pleasure of doing it. (2) Symbolic play (2 to 8 years) involves the representation of an absent object. It is the comparison of a given thing to an imagined thing, for example., the child moves a box imagining is an automotive. (3) Play with rules (7 to 11 years) is considered by Piaget to be the playful activity of socialized beings; it is characterized by the presence of regularized forms of activities and necessarily supposes a social interaction between individuals [21, pp.155-156 cited in 13. p.70]. [6]

For Piaget, play with rules "marks the weakening of child's play and the step to play that is properly adult, that is no more than a vital function of thinking to the extent that the individual is socialized". The key feature of this type of play is that it achieves "a subtle equilibrium between assimilation of the self and social life. It is sensory motor or intellectual satisfaction and, besides, it tends toward the victory of the individual over others." These satisfactions are legitimized "by the actual rules the play inserts into the comprehension of a collective discipline and in moral honor and fair play. The third and last form of play is not different, it is the notion of the assimilation of the self with the real, always reconciling the playful simulation with the demands of social reciprocity" [22 cited in 13, p.74].

Bruner indicates that "play is not just early play. For children and adults, play is a form of using the mind and, better still, an attitude about how to use the mind. It is a frame in which things can be tested, a greenhouse within which we can combine thinking, language, and fantasy. In the same way that one can ruin a greenhouse or a garden by planting too many plants, so to can one create an atmosphere in which neither language nor thinking can bear the fruit one would have expected under normal conditions." [23, p. 219, cited in 13, p.88].

The Rafael Pombo Foundation [12] uses the Winnicott's concept according to which there is in child's play, "a pleasing and tranquil satisfaction which comes from the dexterity with the object, the joy of the pleasure of play, and the confidence in the security of the environment.

The study of play within Winnicott's work is based on the observation of children's play as a creative activity, transcending the idea of organized play. We emphasize from the start how "the function of play, intrinsic to everything humans do that involve spontaneity and originality, is found through the bridge of our cultural reproductions."

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5 Reyes-Navia clarifies that this concept is introduced by Vygotsky to explain the interaction between learning and development, to define an intermediate zone between the level of actual evolution and the level of potential development. Indicating the "distance between the real level of development, determined by the ability to independently solve a problem, and the potential level of development, determined through the solving of a problem under the guidance of an adult or in collaboration with a more capable companion" [16, p.133, cited in 13, p.58]

6 Reviewer's note: [*op.cit*]: Gloria Bejarano says that *play is a way of being, not of* doing. It has to do with the meaning of life, more than with the way it is used; thus, the classification of games in association with states of development is worrisome.

Citing Graciela Montes, the Foundation's study says [24, p. 51 y 52, cited in 12]

> "The theory developed by Winnicott about play speaks of a *third zone*, a territory under constant conquest; a zone of interchange between the within and the without, between the individual and the world, in the interaction of the external world with the internal world. This third zone doesn't come about suddenly. It has to do with a territory under constant conquest, never completely conquered, always being developed, in a permanent state of becoming. It is one zone of interchange between the individual and the world, but also something more: the only liberated zone."

On the other hand, citing Abadi [13, p. 52, cited in 12], the Foundation's study says:

> "In play activity, children reunite objects or phenomena from their exterior reality and use them in service of their internal reality. They show their capacity to fantasize and unfold and take control of a privileged fragment of external reality.
>
> Playing is a way of manipulating external phenomena in service of their dreams, and seeing significance in some of them. With control and limits they discover the unlimited reach of their imagination. Because of this, play favors the notion that life can be used and enriched.
>
> Play accomplishes an essential function in managing aggression and destructiveness. When processed and expressed in a symbolic way, the object can be damaged and destroyed and later repaired, dirtied and then cleaned, killed and revived. Play helps to integrate ambivalent feelings, instead of maintaining a disassociation between good and bad objects.
>
> Play has a time and a place and is found neither within nor without. It is not part of the self nor of the not-self, it is beyond the domain of magic".

BIDIMENSIONAL CLASSIFICATION OF PLAY

Caillois [18, p.39] says that the multitude and infinite variety of play makes one lose, at the beginning, the hope of discovering classification principles that would permit a distribution of the varieties into a number of well-defined categories. Taking into account the different possibilities, this author proposes a bidimensional classification in which one axis represents ways of playing (paidia and ludus) and the other represents the role that characterizes the play (agon, alea, mimicry, and ilinx). The advantage of this terminology is that it forces us to the essential meaning of each row and column and, through that method, to understanding of each cell.

WAYS OF PLAYING: PAIDIA AND LUDUS

Caillois indicates [18, p.39 and pp.65-67] that the term *paidia*[7] includes the spontaneous manifestations of the instinct of play. It relates to the primary capacity of improvisation and the joy of living things: a cat tangling itself in a ball of yarn, a dog shaking water off, the newborn smiling at a rattle. These are basic, identifiable examples of this type of activity. This common origin of diversion, of turbulence, of free improvisation and unconcerned abundance is which Caillois designates with the name Paidia. It is the elemental need for activity and commotion that appears as the desire to touch everything, to grasp, to test things, to smell and later forget. It can readily present itself in the joy of destroying or breaking something. It explains the pleasure of endlessly cutting paper with scissors, of ripping cloth to pieces, of taking something apart or

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[7] *Paidia* is derived from the Greek *paidos*, which means child.

making it fall down, of going beyond a line, of creating disorder in a game or in what others are doing. This type of work is what we have characterized as play-play.

At the opposite extreme we find *ludus*[8], through which the exuberant daring and spontaneity of paidia is almost completely absorbed and disciplined by a complementary tendency. It is opposed by some concepts of anarchic and capricious nature: a growing necessity to submit to arbitrary conventions, intentionally required and bothersome, confusing it more and more each time with trickier obstacles and with the goal of making it harder for the players to reach their desired outcome, which is perfectly useless even though it requires more effort each time, more patience, more ability or genius. In the most basic state of ludus is born the desire to invent rules and submit to them obstinately, regardless of the cost: they walk like a lame duck, backwards, closing their eyes, they play at looking at the sun to see who can stand the pain or staying in a certain position for as long as possible. Whenever conventions are introduced, with them appear the first characterized, or named, games (it is difficult for this to happen with paidia): leap frog, hide and seek, dreidle, blind-man's bluff, or playing with dolls. Ludus gives an opportunity for training, and normally leads to achieving a specified ability, acquiring a particular mastery, manipulating a certain apparatus or in the aptitude to discover a satisfactory answer to problems of strictly conventional order. Within ludus one fights against an obstacle, not against one or various competitors. Regarding the aspect of manual ability, we can cite the South American's balero (also called coca), the diabolo, and the yoyo. Games such as solitaire and puzzles relate to calculation and combination. Crossword puzzles, math games, anagrams, palindromes, and various types of word puzzles, the active reading of detective novels (that is, trying to figure out who did it), problems of chess or bridge constitute yet others among the purest and most widespread forms of *ludus* [18, p.40 and pp.67-69].

PUZZLES: LUDUS THAT REQUIRES THINKING

Without even looking at other dimensions of Caillois' classification, we can assimilate puzzles to ludus when the solution requires thinking. There are problematic situations in which there is a challenge to resolve, the solution to which requires use of higher thinking skills. Here one can use tools of thinking and action, using those permitted by the applicable rules. There are multiple ways to present the difficulty and there is often more than one way to arrive at a valid solution.

Within this view Recaman has done a systematic review of problematic situations beyond those systemized for teaching of mathematics [25] and has classified them with regard to the type of mental process the solution requires [26]: puzzles that are idiomatic and verbal, geometric, visual or observational, topological, arithmetic, logical, algebraic, operational, lateral thinking, and others.

ROLES THAT CHARACTIZE PLAY: AGON, ALEA, MIMICRY, ILINX

Caillois chose four terms for this sub classification, all intimately tied with the concept of play and each one denoting its natural aspect. You can play soccer, marbles, or chess (agon, games of competition); you can play roulette or the lottery (alea, games of chance); you can play at being a pirate, Nero, or Hamlet (mimicry, games of representation or pantomime); you can play at mountain climbing or tight-rope walking (ilinx, games of dizziness).

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[8] *Ludus* is taken from the Latin word *ludus ludere*, play, from which comes the word Ludic (playful): fun, in relation to play.

Table 2. Sub classification of play according to characteristic roles

AGON Games of competition Polo, tennis, soccer, fencing, marksmanship, golf Checkers, billiards, chess, strategy	Competitions in which an artificial equality of conditions are created so that the opponents can confront one another under ideal conditions, with the possibility of assigning a precise and unarguable victory to the victor. It always has to do with a rivalry about ability (speed, resistance, vigor, memory, capacity, genius, etc.) which is performed within the set limits and without external help The practice of agon supposes sustained attention, appropriate training, assiduous effort, and desire to win. It demands discipline and perseverance. The corruption of agon is tied to violence, the desire for power, and the misunderstood ruse.
ALEA Games of chance Dice, roulette, heads or tails, baccarat, lottery, Parcheesi	In these games the arbitrariness of chance constitutes the only resort in the game. In contrast to agon, alea denies the effort, patience, and ability. In one instant the accumulated results can be annihilated. One is either completely disgraced or completely favored. While in agon the player can vindicate himself, in alea he renounces his will and abandons himself to destiny. Alea eliminates the natural or acquired superiorities of individuals with the end of making everyone equal in the face of luck. The corruption of alea is tied to superstition and fetishism.
MIMICRY Games of representation Pantomime, costumes, roles, representations	Every game presupposes the temporary acceptance, of a closed universe, one that is conventional and in some ways fictitious. The game can consist in oneself playing an illusory person and behaving accordingly. The subject plays at growing- at making himself believe, and making others believe as well, that he is someone other than himself. The pleasure comes from being someone else and in passing oneself off as someone else. However, since it is play there is no attempt to fool the observer. The only rule is coherence of representation: the actor should fascinate the audience, avoiding any errors that remove the illusion. The corruption of mimicry is tied to alienation and unfolding of the personality.
ILINX Games of dizziness Acrobatics, tight-rope walking, mountain climbing, roller coasters	An attempt to temporarily destroy the stability of perception and inflict an exciting sense of panic to the lucid conscience. It has to do with reaching a sort of spasm, of trance or bewilderment that annihilates reality with a sudden sovereignty. There is joy in vertigo, more so than distraction because the excitement is closer to spasm than diversion. The essential part is the search for a specific thrill, of momentary panic defined by the end of the vertigo. The corruption of Ilinx is tied to alcoholism and drugs.

CLASSIFICATION OF GAMES

The above sub classifications permit generating a more detailed classification, keeping in mind the way play is done and the role one plays in the game. The following table, prepared by Caillois [18, p.79] illustrates the bidimensionality of the classification.

More than a 2x4 matrix, one should think of a continuum between two extremes (*paidia* and *ludus)* and four types of play that are not necessarily unrelated. Observe the way games that are closer to the type of play called *paidia* can develop the CREATOR, while those games closer to the type of play called *ludus* can develop BEING CREATIVE. On the other hand, each one of them, and all of them, are play-play when used in pure form.

Table 3. Bidimensional classification of games, according to Caillois

Ways of playing	Dominant characteristic of the game			
	Agon	Alea	Mimicry	Ilinx
Paidia				
Making noises Tasting Laughing	Running, fighting unruled competencies	Dicing, Coin flipping	Imitations Illusion games Costumes	Russian mountain Attractions park
Solitaire Crosswords Puzzles	Boxing, billiard, football, chess, sportive competencies	Roulette, Lottery, Gaming	Theater, Performances	Snowboarding Alpinism
Ludus				

It is evident that some play combines the roles (e.g., agon-alea in games of cards, which falls within the world of rules once beyond dealing cards at random; mimicry-ilinx in games of rhymes, within the world of improvisation), but it is less evident that not all combinations exist (e.g., agon-illinx and alea-mimicry, which are incompatible).

Within this classification the spirit of play is in the forefront. In all of play's distinct manifestations ingenuity, improvement, and invention are stimulated. At the same time they promote loyalty in respect to the adversary and provide examples of competencies that in true rivalries do not survive an encounter. Through the paths of play, humanity has the possibility to triumph over monotony, determinism, and the blindness and brutality of nature. One learns to construct orderand to establish equality. But, poorly focused, its social function can lose direction and have noxious effects. This does not mean that it has departed from its nature.

PUZZLES AND LEARNING PROBLEM SOLVING

Many of us have concerned ourselves with learning to solve problems and, beyond that, with learning to learn. Puzzles offer good opportunities for appropriately approaching these challenges, since they appear to be problems of cognitive nature that, when they are relevant, they produce mental tickling and generate disequilibria that motivates thoughtful action. The solution of puzzles demands BEING CREATIVE, as it responds to our capacity to find non-trivial

solutions to challenges that are relevant to us. They are exciting environments in which we must grow if we want to find valid solutions.

PROBLEMS, PROBLEM SITUATIONS, AND CREATIVITY [27, 28, 29]

This anecdote told by Anderson [29, cited in 30, p.16] permits a broadening of the discussion:

> On one occasion I had published this advertisement: Wanted: secretary, good typist, with ability to solve office problems.
>
> One candidate called.
>
> SHE: I'm, especially good at solving typing problems.
>
> I: What do you mean by 'typing problems'?
>
> SHE: Sometimes I have problems finding the correct key to press, but I can always solve it by looking around.

Can it be that the candidate's problem has something to do with her concept of problem? What are we referring to when we speak of problems?

- Tying your shoelaces
- Saying the names of the 25 most populated capitals of the planet and their corresponding countries
- Proving a theorem
- Proposing a creative solution to the problem of transport during rush hour
- Taking a position on removing obstacles to negotiation with guerrillas
- Saying what is yellow on the outside and black on the inside

Can it be that problems are independent of who is in charge of solving them? For example, tying one's shoelaces: is this a problem independent of who is in charge of doing it? It is probably a problem for a child who is beginning school, but not one for his father. For the first, it is a problem to solve, for the second it is a problem that has already been solved. But this is not why "tying your shoelaces" stops being a problematic situation. We can, therefore, say that all the above are problematic situations, but only some of them are problems for a particular person.

Cognitive problems, as stated by Vasco and others [31, p.102] have to do with the insufficiency or incongruity of the mental models that we have in relation to real phenomena. The insufficiency generates amazement or curiosity; while the incongruence generates disconcertedness. These emotions maintain any human being with the desire to search.

They explain [*ibid*] that mental models are a central strategy for the adaptation of our species, equivalent to strength or agility in other species such as felines. These representations serve us daily to orient ourselves in the world and explain phenomena to ourselves. Now, it must be that a model that at one time permits someone or some society to understand one or more phenomena of the real eventually enters into a crisis because it produces a disparity between its representation of the real and the reality itself. The model does not yet adequately explain the real; Let's say that at this moment we encounter a cognitive problem.

They also clarify [*ibid*, p.103] that psychological perspectives and pedagogical construction have shown us that thinking is developed through these problems and conflicts, that they break the precarious equilibrium at which the successful models and theories had arrived, Through that attempt, people can return to a state of equilibrium by transforming their models and theories. This is the reason for the insistence of constructivist pedagogical perspectives on

the teacher as creator of situations for breaking the equilibrium between representations that the students may have to explain the diverse phenomena occurring in their environment. This lack of equilibrium helps the learners find their limitations or contradictions and thus re-elaborate their mental models and accompanying theories.

Problematic situations and problems

A problematic situation can be typified as a planned change of state for getting from an initial situation (a problem that is unresolved) to a final state (problem resolved) through a transition that requires thinking (there is at least an intellectual obstacle to overcome) [27, 28, 29].

As such, a problem includes (1) a solver, for whom the problematic situation is a cognitive problem; (2) some elements provided for solving the problem which condition it (resources and restrictions); (3) a problematic situation, divined in terms of the initial situation, a final situation, and a difficulty that requires THINKING.

Problematic situations and thinking

In regard to THINKING, could it be that the different problematic situations mentioned require the same type of mental processes? Could they all have the same level of complexity? Let's see:

Searching for keys is a problem of selective perception, reproductive thinking, and a low level of complexity.

Tying your shoelaces does not go beyond being an application of rules and motor skills, reproductive thinking, and low-level of complexity.

Proving a theorem, for one who already knows it, is recall of information, reproductive thinking, medium-level of complexity (there are more elements and relationships than in the two already mentioned). And for one who is deducing the theorem, there is analysis, synthesis, and evaluation, productive thinking, and medium- or high-level complexity (depending on the theorem).

The names of capitals and countries do not go beyond verbal information, recall of information, reproductive thinking, and, as a problem, can have a medium-level of complexity.

The proposition of a creative solution for the problem of transportation and taking a position on the removal of obstacles by trying original solutions involves analysis, synthesis and evaluation, productive thinking, and high-level complexity.

The guessing game about the yellow and black object does not go beyond reproductive thinking, even through its complexity can be medium, considering the many objects that could meet the criteria.

Thus we see, depending on whether resolving a problematic situation recalls what one already knows (facts, rules, procedures) or generates what one does not yet know (analysis, synthesis, evaluation), THINKING brings with it reproductive and productive learning (thought). The first refers to what one already has knowledge of, a guide or rule that is reproduced to find a solution, whereas the second shows the generation (production) of a new idea.

On the other hand, depending on the quantity of elements the problem brings with it and the relationships between them, the level of granularity with which one looks (point by point or on a larger scale) at the level of complexity goes from low to high. And this is relative; it depends on the solver and his experience (quantity of hours that he has worked on the problem).

Problematic situations from well- to poorly-defined

The ultimate perspective that helps shed light on a problematic situation is its level of specificity. Reitman [32] says that this is associated with how well defined the initial and final states are. For example:

A well-specified problematic situation is one that has initial and final states that are well defined. For example: Translate this paragraph from English to Spanish without help, in no more than half an hour, preserving the meaning of the sentences.

A problematic situation with a well-defined initial state and a poor goal could be: redesign a Cadillac Eldorado to get better gas mileage (what is that, really?)

A problematic situation with a poorly defined initial state and well-defined goals would be: Explain the mechanisms that cause a total and partial eclipse of the sun.

A problematic situation that is poorly defined is one like: What is a pispirispi? Why?

Problematic situations and creativity

Observe that from our perspective (development of creativity, puzzles, and games) a problematic situation that appeals to us is relevant and new for the solver, it demands high order thinking skills (productive thinking rather more than reproductive), and is not necessarily well-defined. Puzzles with these qualities are highly challenging and solving them can develop both being a creator and being creative.

LEARNING TO SOLVE PROBLEMS

Having clarified that only certain groups of problematic situations have the potential to generate processes that develop creativity in both its dimensions (being a creator and being creative), or at least one of them, the questions is left open, how can we promote these capacities? In the following sections we will attempt various approximations, each of which has merit for having attempted to add value to the issue of learning to learn, of learning to solve problems. In another document [33], we have proposed our own way of approaching the problem, through playful pedagogic guides that promote creativity or problem solving.

Mathetics and some principles for problem solving

Papert complains [34] that there is no word in the dictionary to designate the art of learning, while there is for the art of teaching (pedagogy). Facing this he proposes the expression *Mathetics*, which in its root is related with mathematics but in practice has little do to with it. In effect, he says that upon proposing the term he offers restitution to a semantic robbery made by his professional ancestors who took the word *mathematics* from a family of related Greek words related to learning. *Mathematikos* meant, “disposed to learn”; *mathema* was “lesson” and “*manthanein*” was the verb “to learn”. Mathematicians, convinced that theirs was the real form of learning, appropriated the word and managed to give it such a connotation so that when the prefix *math* appears people think about numbers. Because of this he proposes *Mathetics* to refer to the art of learning, an area of early childhood study according to the most important of mathematics.

To understand the importance of this, let’s spend some time reflecting on the following principles Papert proposes [*ibid,* pp.11-23] for learning to solve problems:

Spend time on the problem: Many problems are not solved because insufficient time is spent to understand them, to see what they are about, see what one already knows, and figure out where the difficulty is. Papert says that learning increases when one keeps trying to achieve it.

Speak freely about how to learn and about learning experiences. For Papert, doing this is like joking about the theme of sex in Freudian theory. Jokes relieve the tension relative to sex, talking about how we learn generates metaknowledge.

Cultivate ideas. Ideas grow like plants in response to the horticulturists work, once planted they grow without further attention. But if one pays enough attention to them, through checking on them and enriching them, they will grow and become stronger.

Look for connections. The deliberate part of learning consists of connecting existing entities; new connections emerge subtly or even unconsciously. This reflective and critical activity can bring us to find meaning in things that have none, to generating new ideas through unsuspected relationships.

Phases of learning to solve problems

Throughout history there have been many efforts to systematize ideas in relation to problem solving. Authors such as Wallas [35] in 1926 and Polya [36] in 1957 have worked considerably on this and generated proposals that lay out the process of solving. The following table shows what each proposed:

Table 4. Phases of the process of problem solving: Wallas and Polya

According to Wallas		**According to Polya**	
Preparation	Get information about the problem and make a preliminary attempt to solve it	Understanding the problem	Gather information about the problem and establish what you want to achieve (what is the unknown), and what are the facts and given conditions.
Incubation	Set the problem aside for a while to work on something else or to sleep.	Designing a plan of action	Do I know of a related problem? Can I reformulate it in another way? What is the most convenient way to solve it?
Illumination	The key to the solution appears (insight, sudden understanding)	Implementing the plan	Implement the plan of action, verifying the outcome of each step
Verification	Verify that the solution works	Review	Verify the solution, if possible using another method, meaning unclear:confronting everything that fits.

Analyzing this table, the reader can verify that there is much similarity between the two propositions. There are also differences worth considering.

One difference is rooted in the type of problematic situations are presented as puzzles to those who seek the solution. Both presuppose non-trivial problems, that is, problems with no direct solution (in both information is obtained and the solver tries to understand the problem).

Polya's proposal sheds light on the domain of mathematics (what is unknown, the facts and given conditions) while for Wallas' solution this is not necessarily so.

Another difference has to do with which creative domain is privileged in each case. While Wallas leaves room for being creative (letting ideas incubate and ensuring illumination), Polya leaves room for having creativity (looking for and applying the most convenient method).

Independently of the domain of the problematic situation, it is the very nature (simple, complex, excessively complex, dependent on the number of elements and their interrelations) and the field of the problem solver (previous experience, developed abilities, and attitude toward problems) that can make either Wallas' or Polya's proposal more appropriate.

Heuristics, or principles for solving problems

Another way of learning, very close to mathetics but within the domain of problem solving, is *heuristics*. Etymologically, this word is derived from Archimedes' shout of Eureka! It refers to the art of intellectual discovery. The idea per se is very old, itgoes back to the Greeks. Descartes made use of it.

Today the concept of *heuristics* comprises "the beginning of problem solving", in counterpoint to "precise use of rules and procedures," which pertains to *algorithms*. Heuristics are principles that can help the solving of complex problems where productive thinking is necessary. In contrast, algorithms are rules that allow us to solve problems that require reproductive thinking. For example, an algorithm is determining what a "pispirispi" is and what is not, once it has a definitionby using a methodic process to examine each case and see if it agrees with the definition But getting to the definition of pispirispi and supporting it, requires making an analysis of the context within which the definition will be provided, taking a position in respect to certain things, valuing others and, finally, a fundamental proposition or creative inspiration. Here it is useful to apply heuristics.

Some of the best known heuristics are outlined by Galvis in his work on "Learning and teaching problem solving" [27], to know: trial and error with creative reflection, similitude, planning, divide and conquer, and analysis of means and ends.

Trial and error, with creative reflection

Though many educators find that trial and error is not a desirable way to attack problems, it turns out to be a very good strategy for learning by discovery, when one learns from the errors and has belief in the student. the basis of this principle.is to Obtain information from the environment, and from the different states of the process of solving the problem, hopefully through the interpolation (Why? What do you already know? What's missing?), and illumination with indirect light (giving clues, not solutions).

Many thinking games are solved by this method. Think of how one moves the pieces in an eight-nine square puzzle (eight pieces, nine spaces). After trying for a while, if one has paid attention, suddenly one notices that there are certain tricks that allow for the unarranging and rearranging the pieces in order to move them to the desired locations.

And, have you seen what children do when given a new toy or computer program that they do not know? Well, they don't read the manual, they ask, "What is the game about?" They use it right away, playing and learning what happens, finding new functions and verifying ideas as they occur to them for how to get ahead and solve the problem.

The big challenge, in all cases, is getting to the point where the tacit knowledge that is generated becomes explicit. The following: "Why? How did you do it?" can make the difference.

Similitude

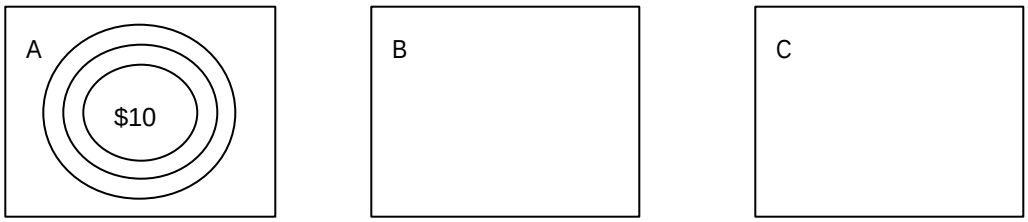
When you are solving a problem and find yourself at state X, try each time to make the next state (X+1) closer to the final desired state. To do this, determine what the goal is and whether there is any possibility of approaching it through, meeting one sub goal at a time,until you can achieve the objective.

In the same eight-nine magic square we spoke of earlier, it is evident that the movement of the different pieces is governed by this heuristic. Knowing the final state of the pieces in the square, you can direct your efforts so that, one by one, the pieces are arranged as desired. The square with the number 1 in the upper-left corner and so on. Dedicating yourself to the challenge of getting to the state of I+1 the number that follows to its appropriate place unclear phrase:increases the value of what you do with trial and error.

Planning

There are occasions in which taking a step takes us further from the goal, but when looking at the steps as a group you can see that you can use them to solve the problem. To do it, you have to advance from the initial point toward the desired one, identifying the different steps you should take to find the solution (bottom up analysis) or going to the final state, asking yourself what steps must have been taken previously in order to get to the actual state (*top down* analysis).

Have you played Tower of Hanoi? If not, this can be a good exercise for understanding what planning, similitude, and trial and error mean. Get three or four coins, of different sizes, and draw three squares on a piece of paper marked A, B, and C. Put the largest coin on the bottom in square A, the medium one on top of it, and the smallest on top. Now try to get the three coins into square C in the same order, (1) moving one coin at a time, (2) without putting a larger coin on top of a smaller one, (3) with the smallest possible number of moves.



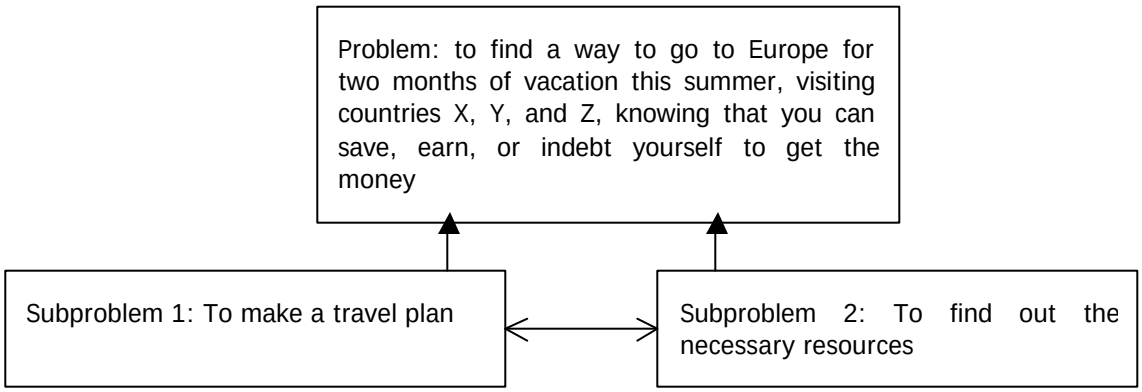
When you have managed to do the three coins in seven steps and four coins in fifteen, you will have solved the problem (If so, how many steps will it take with five coins?) When you have reached this level, read the following reasoning.

Surely you used the three heuristics discussed up to now. Through trial and error you possibly determined where was the best place to start putting the smallest coin, whether in square B or C, until you figured out the problem with the smallest number of steps. If you felt tempted to move all the coins from A to C, maybe you weren't paying attention to the wording of the problem, but that is not similitude. That would require addressing the sub goal of getting the largest coin to the bottom of C without directly putting it there (getting closer to the final state by going through the state X to X+1). Since it is impossible to move the largest coin directly while it has coins above it, you certainly planned out what was the best way to move the others without making unnecessary moves.

Divide and conquer

This military expression of Julius Caesar helps us solve problems by breaking them apart. The original problem is divided into sub problems and each of those into sub-sub problems, until getting to the point where you know the solution to each subdivision. Collectively the individual solutions lead to the final solution.

Have you dreamed about traveling but not had enough money? What about using "Divide and Conquer" to find a way to go to Europe for two months of vacation this summer, visiting countries X, Y, and Z, knowing that you can save, earn, or indebt yourself to get the money. The following diagram can help you to understand Divide and Conquer: If you continue dividing each sub problem into more sub-sub problems related to it, until you identify those that can be directly resolved (e.g., getting information about tourism),you will have used Divide and Conquer to solve the problem.



Analysis of means and ends

If a problem has a direct solution, use it; if not apply "divide and conquer" (divide it into sub problems) and try again. The direct solution refers to a solution that is known and can be applied. Divide and conquer is the above-mentioned heuristic.

The following fable, "Stone Soup" by Aesop, serves to illustrate this point:

> A poor man came to a mansion during a storm to beg for food. The maid refused him and sent him away with harsh words. But he came back and knocked again and, seeing the wood stove asked: "Could I at least dry my clothes by the fire while I shelter myself from the rain?" The maid thought this would be okay and let him in.
>
> Once inside, the beggar asked the cook for permission to use a pot with a little water to make stone soup. Surprised by the oddness of the meal, she agreed. The beggar took a stone out of his pocket and put it with the water to boil. Then he asked if they could spare him some salt to give the soup some flavor. She gave it to him, along with meat, peas, and other foods she was going to waste. Through this method, the man made a delicious stone soup and the cook exclaimed, "Well done, you have made something out of nothing!"

What was the goal? What was the direct solution? What sub problems appeared for applying divide and conquer? Did they have a direct solution? Did he again apply divide and conquer?

Heuristics and educators

Heuristics, or rules for solving problems, can be valuable aids when being a creator and being creative. Understanding them, and valuing and incorporating them into the way people think, can make them a focus and a way of seeing things, rather than simply a recipe. These principles are tacit knowledge we all have, that we know how to use almost by instinct. Once we've made them explicit we can apply them rationally. This is one of the great challenges we face as educators.

The other great challenge for educators is to be clear about what underlies this learning to discover (Eureka!) that we want our students to have. That is where it can be necessary to be careful in the role of teacher, assuming coherent positions. One very valuable work regarding this was done by Dwyer [37], where he sets forth the principles for orienting teachers in this task:

Help the student to construct his own mental models in relation to accumulated experience. Inheritance and cultural and scientific heritage can be transmitted using an algorithmic focus (transmitting knowledge), but going beyond that, understanding that heritage and taking advantage of it, creates new criteria. Being capable of resolving problems autonomously requires a heuristic focus.

Expect the unexpected in relation to educational self-direction. Believe in them, give them the opportunity to construct their own mental models, leave them be in their underdevelopment since they have what it takes to get ahead. become motors for creativity by Learning through error and reflection, and the constant search for ways to get to a solution

Use rich and pleasing learning environments. Learning and play go hand in hand. The real and virtual objects that are put at the learner's disposal should help promote pleasing and meaningful experiences. Curiosity, fantasy, speculation, and experimentation are developed more easily in these types of environments.

Rediscover yourself as a teacher. Continue being an expert and enthusiast in your area of competence, but rediscover yourself as a teacher. Be a guide and facilitator for the learners' discovery. It is not easy to assume this role, but it is necessary to do so if we want a relationship with students of dialogue, and of assessor (the one who sits beside them), not boss.

PUZZLES AND PLAY IN LUDOMATICA

Play and puzzles are crucial in Ludomatica. As Bejarano says [11] "LUDOMATICA is a project turned into a game, created to enter the free zone through imaginary ones, exploration, investigation, reflection, and collaboration. Its educational action is encoded within the search for new paths for accessing the knowledge and for developing new spaces for creative being. It attempts to collaborate in the processes of transforming the participating institutions, obtaining spaces of creative participation for boys and girls which acknowledge them as protagonists of their own development and, for the institution, an educational perspective that permits a broadening of the conceptual horizon and acts in the redefinition of educational policy and projects.

THE GAME OF LUDOMATICA

Ludomatica is a play-project-play where the goal is to create a new educational space, a new way of thinking of institutional change, which precipitates the transformation of the participating educational institutions through a change of paradigm.

the constituent elements of the proposition. Are The playfulness (beyond entertaining and fantastic, a form of joining life and knowledge), the creative (generator of living propositions, transformation, and vital development), the collaborative (through the positive interdependence between participants) and the interactive (through the direct interaction with the object of knowledge and with the other explorers and navigators) The actors are the educators, boys, and girls, who are involved in the creation of spaces of creative participation in which they recognize themselves as protagonists in their own development.

The setting is each one of the participating institutions that have a new educational perspective that permits a broadening of the conceptual horizon and acts in the redefinition of educational policy and projects.

The working tools are a pedagogy that is problem-based (centered on problems, not content) and constructivist (learning under control of the learner, constructing the knowledge), which implements the constituent elements of the project through six ideas. This forces the use of previously mentioned integrated resources.

Bejarano points out in the review of this document [10] that the educational challenge consists of advancing toward the path as participants of new proposals, and understanding the social-scientific dynamics and technology of the times. The project enters with a pedagogic construction; it is an effort to overcome our role as unthinking consumers of new technologies. On the other hand, we know that we are part of a culture within which we easily become "devourers of visual images, not mental ones". Thus arises the interest in offering an experience of thinking, elaborating, and constructing knowledge.

Six strong points (Tracks, Borders, Accompany, Habitat, Paths, and Change), are set out as "stages of knowledge"[9] for the understanding of the pedagogic interaction in the playful, creative, collaborative, and interactive attempt to lay out the possibilities of the development of boys and girls, educators and particular institutions in which the activity is brought to completion.

Tracks. This concept attempts to favor *multiple readings* that provide recognition of the self and the environment. The pedagogic meaning is in the value of the wise content from life stories and in the form of making the known information visible in the tracks left behind in the places, objects, and people with which we live. This concept puts into play the importance of following the trail, of tracing a map, of deciphering and registering tracks. All of this serves to generate new reading and new knowledge.

Borders. This concept is directly associated with the territory of play and creativity. It is a place that implies limits, change, interaction between different worlds, back and forth movement for the construction of new knowledge. With this reflective exercise we attempt to recognize the essence of a project that plays into change, to challenge, to the search and uncertainty, placing them within the territory of transition, appropriate for creative effort: new readings, new relationships, the ability to deconstruct in order to produce new orders and new knowledge.

Accompany. With this concept we try to make visible the thread that connects the relationships between generations. We emphasize the importance of a pedagogy of dialogue and participation containing an educational effort based on the construction of knowledge, in the recognition of the other and of the collaborative forms of work; which emphasizes the value of accompanying the processes in the evolution of experiences.

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[9] Stages of knowledge for stopping to reflect, on the multiple possibilities of pedagogic interaction, taking from each main idea, a using a lense to focus on different angles on the process of work.

Paths. This has to do with the importance of recognizing various ways to get to knowledge within a problem-based and constructivist pedagogy. The idea of "paths" permits thinking of a learning process tied to search, exploration, and integrity of expression. Similarly, it considers multimedia forms and relationships that are non-linear or networked.

Habitat. This is a concept directly associated with playful, creative, and collaborative processes in two ways: in the fertilization of the pedagogic proposition put into action in educational micro worlds (learning environments as such), and in the incidence of the educational macro world (institutions and their conditions) within the transformation process. Thus, given the premises of the work, it is fundamental to keep in mind the relevance of the intermediate and immediate environment as facilitators or obstacles to creative processes.

Change. Change does not only mean a new meaning, a new structure, a new language, and new types of relationships. It is a permanent state in the educational process, an open attitude and a disposition toward accepting the transformation of the existing when motion sets out new coordinates. The project identifies change as a constant. It shows the milestones in the work process and reflects the aspects that define whether the proposition is developed in a way that is creative, playful, and participatory. It determines the impact of the experience in the institutional and educational environment.

Within this pedagogic proposition, play and puzzles of all kinds, when put in the context of creative workshops and local or global LCCI[10] projects, can contribute significantly to making the dreams of paradigmatic change become a reality so that we can form children and reeducate educators with the desired qualities.

PUZZLES IN THE GAME OF LUDOMATICA

The following ideas on puzzles in the game of Ludomatica, extracted from the conceptual document for the project [*op.cit*], open new paths for exploring, and bring us to reflect on basics.

The puzzle in the game of LUDOMAICA has a living relationship and meaning. Humans have always asked Who am I? What else exists? What will the future be like? Since ancient times, when man managed to conquer the territory of thought, he has wondered and asked these questions Puzzles are part of the myths of Greek culture, where the gods entertained themselves by testing men as in the case of the Sphinx. In the same way, puzzles fit into the work of politics, art, and literature.

Philosophical and religious problems and scientific curiosity make life a big puzzle that has many other questioners. Each day we find ourselves in the game of trying to find certainty in so many things: in love, in the lottery, in the stock market in work, and in sports competitions. This part of the human condition, searching and figuring out, is the manifestation of one of the characteristic traits of being creative.

The playful language of puzzles, within the proposal of participation and creativity, and social and artistic esthetics, becomes a key strategy for developing the project, especially if these puzzles are part of collaborative relationships with which we seek to create highly interactive

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[10] LCCI: abbreviation of Lúdicos, Creativos, Colaborativos e Interactivos (Ludic, creative, collaborative, and interactive), the constituent elements of Ludomática

computer-based environments. Similarly we attempt to integrate them with the contextualized visions of the involved disciplines (computer science, pedagogy, literature, play, plastic arts) with the goal of giving puzzles a role in the work of developing methodological tools for enhancing creative productivity.

Puzzles have a special meaning in the pedagogic construction of LUDOMATICA. Having shared the base of telling what we have and what we are (See *Tracks* and [38]) to develop the proposal, we noticed that the participation of boys and girls in unprotected situations of risk brings with it the condition of belonging to the fringes of society most affected by the educational, social, and economic problems of the country. Thus, this difficulty constitutes a big puzzle to solve in the process: How to get into the knowledge era with the existing barriers and known limitations? Solving this problem is not just a national question; it is also a question for the institution, for civil society, and for each individual. This question implies, for this project, searching for paths for educational development starting with the particular reality of each institution that is committed to this work of creative construction.

From a pedagogic perspective, a puzzle is not an exercise in entertainment for testing the intelligence of the player. A puzzle is a way of setting the problem within the natural life of the project, asking and wondering in order to advance knowledge. Within the environment of LUDOMATICA, the real fantastic city is a puzzle, "It occurs with cities as with dreams: all that can be imagined can be dreamed, but even the most unexpected dream is a puzzle that hides a desire or, to the contrary, a fear . . ." [39].

FROM THEORY TO PRACTICE

The ideas presented in this document are only valuable when put into practice. For this reason we are generating, within the context of the Ludomatica project, a group of learning environments where they can be brought to practice. The following is a brief description of them:

TECHNOLOGICAL INTERACTIVE TOOLS

Fantastic City: An interactive multimedia where the enigma of Huff-terr (the monster with four heads, which represent the four natural forces) serves as a challenge for the boy or girl who plays, trying to solve it. It is a labyrinth city with seventeen scenes in three levels (air, earth, and subterranean) that are very meaningful for children, In each of them there are people, objects, and characters which are puzzles to solve. Solving these gives clues for solving the codes for each of the forces of nature and together they make it possible to placate Huff-Terr. Teachers can edit the puzzles in two ways: they can change the content of those that are verbal or logical-perceptual, they can choose which should be presented to the children through classification of difficulty and type. The students' work is cumulative (the program keeps a history), thus it is possible to do work over the course of various sessions without losing what has been done and thus analyze the progress made and reorient the action as required.

Editor-launcher of idiomatic and verbal puzzles and logical-perceptual puzzles [*&]: permits defining or editing the content of puzzles such as: crossword, alphabet soup, guess the phrase. Also allows to choose drawings to be taken apart into little squares in the form of jigsaw puzzle.

Games of thinking [*&]: permit solving tabular thinking games, within a group of three digital games for one or two users. You can assign the level of difficulty of the game.

[*&] This is a product of the *Play and Puzzles as Creative Learning Spaces* project

The editor of assigned puzzles: permits, for any given round of use of the Fantastic City, a focusing on the puzzles that the educator considers pertinent for the users (according to level, type, or both).

DIGITAL INFORMATION SERVICES

Which include access to an indexed collection of:

- Ludopedagogical guides for orienting the playful, creative, collaborative, and interactive playful use of the Fantastic City and the manipulation of puzzles of all kinds[*&].
- Creative Workshops, generated by the pedagogic group of the project and at the core of the participating institutions.
- LCCI projects in progress and realized, for supporting innovative educational processes in which learning for projects with positive interdependence becomes playful and interactive.
- Puzzles [*&] classified according to mental process that can be set out using both digital and non-digital media (pencil and paper, objects, etc.)
- References to web sites where collaborative educational projects, digital educational resources and relevant digital documents exist for the use of computer science in education.
- Documents generated by UNIANDES-LIDIE which are in the public domain (published) or that are working papers (internal discussions).

INTEGRATED LEARNING ENVIRONMENTS

Ludomatica classrooms in the project's implementing institutions, have computers and software for heuristic learning, Internet connection and access to digital information services, thinking games, building toys, reference materials, and materials for creative work.

Master classroom support Ludomatica with integrated learning resources, in the Rafael Pombo Foundation and in the locations of the additional groups involved in the project.

A system of life-long learning is available for educators in the playful, creative, collaborative, and interactive pedagogies:

Accompanied pilot model (18 months): four phases (diagnostic and vision, appropriation of the pedagogic proposition, financing in local and global LCCI projects) through which we seek to produce an educational transformation with informatics in the participating institutions. At least one staff member (the principal, the elementary education coordinator) and two teachers are available to dedicate themselves to the project approximately half time without this removing them from their work, without re-qualifying them. We do follow up, assessment, and evaluation of the impact on the institution, educators, and boys and girls.

Distributed mode tutoring (3 weeks, one per semester) and virtual accompaniment (3 semesters): The multidisciplinary group that rolls out Ludomatica in a region comes to three training sessions in Bogotá with the goal of living the experiences and appropriating the methodological and technological tools of the project. Later, in their regions, they carry out the implementation of local groups, counting on virtual support

Intensive tutoring mode (2 months): A sojourn within Ludomatica where the participating educators live playful, creative, collaborative, and interactive experiences as a basis for rethinking what they do as teachers and generating a proposal for the LCCI project that can serve as a prototype at their institution. This is done following the assessment of the development of each one of the classroom projects.

Instrumental mode (1 to 3 days): intensive creative workshops on the playful, creative, collaborative, and interactive pedagogies so that they will be pertinent to any given group. Follow up with participants as appropriate.

LEARNING FOR THE KNOWLEDGE SOCIETY

This document has made me reflect on how to achieve coherence between what one wants outside of the educational process and what can effectively be brought to practice within a given educational setting. It has definitely produced more questions than answers. To close this work I would like to share them with the reader.

Environments that favor change: though many educators are disposed to change and want to change toward this type of problem-based and constructivist pedagogies, they cannot necessarily rely on institutional resources or even the appropriate organizational climate for bringing them to practice. What should be done? How do we overcome these barriers?

Overcome curricular tensions: The tension between content and abilities has always existed. But now, more than ever felt before, every time the scientific technological, cultural and humanistic communities tend to be ever broader and deeper, emphasizing at once the importance of achieving capabilities such as those demanded by the knowledge society. Creativity, capacity to communicate with others and to work in groups, to set out and solve problems, to learn and unlearn, to be flexible, are critical in this knowledge society. How can we get ahead in a change of educational paradigm if the individual parts follow the daily trends and there is no room to do everything desired in each area of knowledge?

Generate resources for learning: One cannot always count on doing what one wants, and when that is achieved, it is not enough to address the entire school population, much less that part of the population that does not have access to those resources. How do we overcome these limitations? How can we achieve maximum use of what we do have and how can we get what we do not have?

Recognize the value of innovation. Many educators do not change, despite having found it desirable and valuable to do so, simply because it makes no difference institutionally. Their stability and professional development do not depend on the effort they make to break paradigms, to innovate ideas, practices, or use of resources. Can we expect something, in terms of bettering education, under the usual policies of incentive? How can we recognize the value of innovation beyond the personal satisfaction of those who do it?

Encourage play-play (paidia) as a creative activity. Except in the earliest grades (preschool and primary) where this is an established practice, the other grades in the formal education system and the majority of the formal and informal learning activities use very little of this mode of learning. Creative workshops are a rarity and their practice, beyond preschool, is limited to the arts. Could it make sense to bring these types of environments to different learning settings? How would that be achieved?

Make the use of puzzles (ludus for thinking) as a way making cognitive disorder. Many problems that are set out to students do not generate cognitive disorder, they do not include insufficiency or incongruence in respect to the models the students have of reality. As teachers we fall short in knowing our students and thus being able to give them challenges that really move them from where they are and make them grow. How can we encourage learning environments that are rich in relevant and disorienting problematic situations? How can we succeed in generating a thirst for learning in our students and teachers?

Develop heuristic focus. As educators and parents of families we understand the principles (heuristics) for promoting learning and for learning how to solve problems. However, we remain

in the middle of the learning process. It requires effort to illuminate indirectly, to give the opportunity for the learners to experiment and think, let them learn from their own errors and those of others. It is easier to pontificate and impose our own mental models. How can we develop experiences that convince us of the importance of getting to knowledge by one self, constructing mental models about what is interesting to us or what concerns us? How can we learn to assume this role in both physical and virtual environments?

Re-qualify algorithmic focus and non-creative processes. This is not about learning everything constructively, nor pretending that everything should be creative. Much of accumulated knowledge, in particular that of the reproductive level, can be acquired through transmission, taking advantage of media and methods that assure that Gestalt calls good form. Equally, many things should be done as they are written, following the instructions. It is no use to be creative in these cases. One must be disciplined. How can we concern ourselves not only to favor a greater degree of heuristic focus and creative thinking but also rescue, in the right amount, algorithmic focus and non-creative processes? How can we value both axes of the continuum and know how to move from one to the other according to what is needed?

I know that the answers to these questions demand commitments, individually, of groups, and of institutions, and a big dose of creativity and much concerted effort. The play and puzzles of life are to great a challenge for us to resignedly let them pass by, and not taking part makes that happen. We have found through this study not only reasons for doing it, but also principles and tools for participating in the construction of a new educational model.

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