

## THE MATH-GAMES METHODOLOGY

### MATHEMATICS AND THE ROLE OF GAMES IN LEARNING AND TEACHING - WHY USING GAMES IN LEARNING MATHEMATICS?

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#### The Goals of Mathematics and its Centrality in an Adult's Life

It is generally agreed that doing mathematics is a critical skill for all, adults and children, geniuses and people with limited intelligence, persons with high education and individuals with low literacy and knowledge.

In quite a number of reports it is recognized and stressed that in order for adults to function (reasonably well) in an increasingly complex world, they require a basic level of numeracy, which is increasingly necessary in a range of life-skills, such as personal finance and data handling. It is also accepted that mathematical skills (at least at the very elementary level) are increasingly needed in the workplace and in everyday transactions between people.



It is not by chance that Aeschylus, 25 centuries ago, in the "Prometheus Bound" is adding that besides the fire, which Prometheus gave to people, he points out "And yes, I invented for them numbers,

too, the most important science"\*. This reveals the close relation of humans to mathematical literacy and their need to develop mathematical skills, at least at the elementary level.<sup>1</sup>

These basic skills are obviously reflected in the main goals of mathematics education, which are to prepare students to:

- Solve problems
- Communicate and reason

<sup>1</sup> Prometheus was chained to a high rock as punishment because he brought salvation to man, by stealing the gods' fire, but also by giving man numbers and their meaning. Thus, already 2,500 years ago, Aeschylus in his "Prometheus Bound" confirms the **importance of numbers for mankind**.

<https://www.youtube.com/watch?v=kcWdcGwd844>

- Make connections between mathematics and its applications
- Become mathematically literate
- Appreciate and value mathematics
- Make informed decisions as contributors to society.

As can be seen the majority of these goals are immediately related to general life skills, that are expected for any adult and consequently it is justifiable to promote the learning of this subject to any person irrespective of his/ her ability and degree of intelligence.

#### The Role of Games in Learning Mathematics

So we have to promote Mathematics learning by any means. In view of this need the question now becomes "How can Games promote the Learning of Mathematics?" Particularly this question becomes more important in the case of Slow Adults Learners. The Background that can support a successful promotion of Games in the learning process can stem out of expectations that can have positive impact on the following aspects of human behavior: **cognitive, motivational, emotional and social**. Existing research, although not extensive as yet, supports this positive impact. Particularly in the case of Slow Adults Learners the positive impact on the motivational, emotional and social aspects is crucial and it is expected to have positive influence on the cognitive aspects as well.

In Psychology it is recognized that Play brings joy. And it is vital for problem solving, creativity and relationships. This is true for every person either a child or an adult. In particular this is vital for slow learners as it is one of the very few sources to provide these elements, while for other adults there may be other sources as well. Furthermore research in Psychology relates Play with much social behavior that we want either to enhance (if they are directing to the right direction) or to diminish (if they are leading to the wrong direction).

For instance, a psychologist found that lack of Play was just as important as other factors in predicting criminal behavior among murderers in Texas prisons.

Thus when we are dealing with the use of Games in the processes of teaching (and hence learning) we would better employ techniques and methods aiming at:

- **Creating Interest and Promoting Motivation**  
A Game is a sequence of interesting choices. By engaging the learner in such a process motivation is

activated and thinking (including critical one) is taking place.

- **Utilizing the Benefits That Games Provide in Engaging Learners in an Environment of Experiential and Active Learning**  
The interaction in a game creates a better understanding for the learners in regards to the objects, concepts, processes and even the other learners involved
- **Socializing the Persons Involved and Exploiting the Competition and Challenge Element**  
Games are part of everyday life-socialization. This is particularly important in the case of slow learners as their slowness might have its roots in their lack of social relations and interchanging eliminating ideas or low morale.
- **Connecting to Real Life Situations**  
Quite many games reflect actual activities of life and thus they provide the element of usefulness.
- **Developing a Happy and Joyful Environment**  
As already mentioned the joy element is a plus in the learning process.
- **Utilizing the Design (Structure, Rules, Equipment, Problem Posing etc.) of a Game in Order to Develop an Appropriate Learning Approach**  
The components of a game, particularly the ones characterized by aesthetic, illustrative, energetic activities can be exploited for meaningful learning. Also the problem solving elements provide ample ideas for strategic and critical thinking.

### The Math-Games Methodology

The Math-Games methodology encompasses a series of activities that will provide a teacher (and in particular a teacher of slow learners adults) the background for using Games as an educational medium in developing mathematical literacy. In this context it includes three main outcomes (a Math-Games Compendium, a Math-Games Guidebook and a Math-Games Teacher Training Course) that support various approaches and methods for learning and teaching.

### Factors that are to be considered in adopting the Math-Games methodology

In designing a lesson through the adoption of the Math-Games methodology and considering that the main target group of learners is going to be slow adult learners it is useful to take into consideration a number of factors reflecting some of the possible difficulties of these learners. The effort will be to exploit the power of Games in order to alleviate or diminish these difficulties. Such factors include the following ones:

- **Language Issues**  
In mathematics classes, language problems are evident when students have trouble using symbols of math, expressing math concepts to others, and listening to mathematics explanations. Problems also appear in expressing math “sentences”.

- **Cognitive Factors**  
These may be attributed to perceptual, memory, attention or reasoning factors. Perception involves taking in information from the environment and processing that information for storage or use.
- **Metacognitive Factors**  
Metacognition is an awareness of the skills, strategies, and resources that are needed to perform a task and the ability to use self-regulatory mechanisms, including adjustments, to complete the task. Students with metacognition problems have trouble selecting and using effective learning strategies. Games could provide the forum to face such difficulties.
- **Motor Factors**  
Motor skills, like perceptual ones, involve more than one process. They may involve memory of the symbol along with its actual formation (visual and motor memories). They may involve visual perception and transfer (copying). Or they may involve integration of fine muscles with task demands. Indicators of motor problems are highly visible: poorly formed symbols, little control of spacing, excessive time for a task, and avoidance of written work.
- **Social and Emotional Factors**  
Such factors cover a very broad spectrum including peer relations, cooperation, self-esteem etc. Games again could provide a medium for facing them.
- **Habits of Learning**  
“Habits of learning” refers to how individuals view and participate in learning, their self-discipline and self-motivation, goal setting, engagement in learning activities, and acceptance of challenges.
- **Previous Experiences**  
Particularly in the case the learner had negative previous experience he refuses to get involved in the learning process. Games again could alleviate such negative experiences.

Consequently what we have to take into consideration in designing our plan for teaching using the Math-Games methodology could be summarized as:

- Type of slow learner (is the slowness due to other learning areas?)
- Background in Math
- Socialization needs of the person
- Motivation needs and indications that the mathematical content of the game relates to everyday life
- Provision of opportunities for the use of the previously mentioned benefits

### General Approaches for Using Games in Learning Mathematics

Obviously the approach one will adopt for using Games in the learning process depends on a number of goals that we want to achieve ranging from the mathematical area or topic to the considerations mentioned just in the

previous paragraphs, reflecting the benefits of the methodology. In this context we can suggest the following approaches:

- **Using the Methodology as an Introduction to a Mathematical Topic**  
The idea is to ask the learners to play a game that can be associated with the learning objectives of the particular game. Playing a game can be used as a brainstorming. This idea is expected to be the basis for motivation and developing of interest. It can also be used as an icebreaker both for the relations of the people involved in the learning process (learners and teacher) and for the attitudes of the learners towards mathematics (which are usually negative).
- **Using the Methodology for Creating a Happy and Joyful Environment**  
This idea develops positive conditions for learning and thus overcoming negative attitudes and anxiety.
- **Using the Methodology as an Actual Educational Medium for Comprehension of Mathematical Concepts and Processes**  
Obviously such an approach is a substitute for a more traditional one with the advantage that it exploits the benefits of the methodology.
- **Using the Methodology for Consolidation of Otherwise Learned Concepts or Processes**

It is a fact that learning process, particularly for mathematics, demands such an approach.

- **Using the Methodology for Relating Mathematics to Real Life Situations**  
The identification of uses of mathematics for real life situation is an asset for adults as the need to see applications of what they have to learn.
- **Using the Methodology for Developing Problem Solving and Critical Thinking Skills**  
It is a major goal that every learner develops such skills. Games are ideal for strategic thinking, planning and designing approaches to face problematic issues. It provides the forum for meaningful learning and not just rote memorization.
- **Using the Methodology for Boosting Creativity, Productivity and Innovation**  
This idea enhances the skills of the learners and provides a fruitful approach for learning. It can be utilized for adaptation of games or constructing new ones by the players.
- **Using the Methodology for Fixing Relationship Difficulties among the Learners**  
As mentioned earlier such an approach can create a cooperative, challenging and joyful environment, thus creating ideal conditions for learning.

The following table indicates some examples for the various approaches that are presented in this Guidebook:

Approach	Game presented in the Math-Games Compendium and in the Guidebook
Introduction to a Topic	1.2 Checkers
Joyful Environment	4.1 Petanque
Educational medium	1.3. Damath, 10.1 Okey, 3.2 Math Scrabble
Consolidation	10.3 Sudoku
Math in Real Life	3.3 Monopoly
Problem Solving and Critical Thinking	2.3 Combination 9, 7.1 Magic Square, 9.3 Nim-Game
Creativity, Productivity, Innovation	1.4 Tangram, 8.2 Skipping Rope
Fixing Relationships	5.2 Seven Steps, 8.3 Hora

## HINTS TO USE THIS GUIDEBOOK

- The objective of the guidebook is to provide teachers and educators with material to help them teach basic skills in mathematics.
- The guidebook includes 33 games.
- The best way for the teachers to choose the one that better suits them is to check the Synopsis (p. 10) where there is a list of the games and also the mathematical content that is associated with each one.
- Each section of the guidebook is dedicated to one game.