

## **How Prerequisite Skills are Acquired?**

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The prerequisite skills (sequencing, spatial orientation/space organization, pattern recognition, visualization, estimation, deductive thinking, and inductive thinking) are non-mathematical skills that affect mathematical conceptualization. The presence of these prerequisite skills in a child's repertoire facilitates mathematics learning. In that sense these skills are 'anchoring' skills. These skills are best acquired in non-mathematical contexts. When children are playing with games and toys, they are naturally engaged in learning many of these prerequisite skills and eventually these skills transfer to academic settings such as mathematics and science.

Many parents want to work with their children in mathematics. However, many of them feel that they have limited mathematics training and understanding of mathematical concepts. In such situations, parents should work on mathematics proper only if they feel comfortable with mathematics; otherwise, they may transfer their anxieties and fear of mathematics to their children. Some parents may not demonstrate patience with children having problems because of their higher achievement expectations for their children. They may also mix the roles of parenting and teaching that may cause some difficulties.

However, there is a great deal parents can do. They can help children acquire these prerequisite skills. In other words, parents can leave the job of actual mathematics teaching to teachers and tutors but could devote a lot of time with their children playing games and toys that will help children acquire these prerequisite and support skills for mathematics learning. Then children would be better prepared for learning, in general, and mathematics learning, in particular. Then teachers can do their job better.

To be useful in developing these prerequisite skills, games and toys should have certain basic characteristics:

1. Games selected should be based on strategies. In other words, to be proficient in a game should mean being proficient in the strategies; i.e., with each encounter with the game or toy, the child discovers something more about the game—a strategy, a perspective, and a relationship between moves. Such games are interesting to novice and experts alike.
2. The game should last on average ten to fifteen minutes so that children can see the end of the game in a fairly short period of time so that they can understand the relationship between a strategy and its

impact on the game. This teaches them the foundation of deductive thinking: cause and effect. Only when a child has more interest and maturity and is able to handle delayed gratification are complex strategy games such as chess meaningful. For some children, games such as chess sometimes become ends in themselves, which is fine, but then they no longer are serving the same purpose as we advocate—preparation for prerequisite skills for mathematics learning.

3. The games should involve one or more of these prerequisite skills both directly and indirectly. For example, the commercially available game *Master Mind* is an excellent means for developing pattern recognition, visual memory, and deductive thinking in children and even in adults.

Games and play provide good opportunities for discussions of strategies used, outcomes expected, and feedback to improve strategies. Regular discussions are a good way to get children to communicate concepts while sharpening their thinking skills such as their ability to make inferences, to back their arguments with reasons, and to make analogies—skills essential to learning and applying mathematical skills. In an environment where discussions are encouraged, children begin to ask questions not only of their classmates and of siblings but also of parents. They learn to evaluate answers, draw conclusions, and follow up with more questions both of convergent and of divergent types, which strengthen facility in reasoning. Reasoning is the core of mathematics learning. Discussions prepare children for reasoning otherwise they become only procedurally oriented. Too much procedural or ‘recipe’ learning eventually leads a person to boredom in mathematics. The culture that inculcates mathematical thinking does not emphasize just formal mathematics learning but it also provides for the development of skills that are acquired in informal settings and are fore runners of formal mathematical thinking.

Every teacher and parent has a favorite list of games. Some games might have been prepared or collected for a specific purpose—reinforcing a skill, teaching a concept, strengthening a process, or just offering plain entertainment. Following is a partial list of games and toys, I have collected and used extensively with children and adults to help develop the prerequisite skills and mathematics concepts and thinking described above. I have identified the appropriate pre-requisite skills in each game:

- **Simon** or **Mini Wizard** (sequencing, following multi-step directions, visual and auditory memory)
- **Battleships** (spatial orientation, visualization, visual memory)
- **Cribbage** (number relationships, patterns, visual clusters)

- **Quarto** (spatial orientation/space organization, patterns, classification)
- **Concentration** (visualization, pattern recognition, visual memory)
- **Chinese Checkers** (patterns, spatial orientation/space organization)
- **Pachisi** (sequencing, patterns, number relationships)
- **Checkers** (sequencing, patterns, spatial orientation/space organization)
- **Othello** (pattern recognition, spatial orientation, visual clustering, focus on more than one aspect, variable or concept at a time)
- **Score Four** or **Connect Four** (pattern recognition, spatial orientation, visual clustering, geometrical patterns)
- **Qubic** (pattern recognition, spatial orientation, visualization, geometrical patterns)
- **Pyraos** (spatial orientation/space organization)
- **Krypto** (number sense, basic arithmetical facts)
- **Go Muko** (pattern recognition, spatial organization)
- **Kalah** or **Mankalah** (sequencing, counting, estimation, visual clustering)
- **Master Mind** (sequencing, logical deduction, pattern recognition)
- **Four Sight** (spatial orientation, pattern recognition, logical deduction)
- **Black- Box** (logical deduction)
- **Reckon** (number facts, estimation, basic operations)
- **Card Games** (visual clustering, pattern recognition, number facts) (see the games under the number war games)
- **Dominos** (visual clustering, pattern recognition, number facts) (see the games under the number war games)
- **Hex** (pattern recognition)
- **British Squares** (spatial orientation)
- **Stratego** (spatial orientation, logical deduction, graphing)
- **Number Safari** (number facts, a paper/pencil game)
- **Pinball Wizard** (number facts, a paper/pencil game)
- **In One Ear and Out the Other** (same as Pinball Wizard)
- **Number War Games** (visual clustering, arithmetic facts, mathematics concepts).

Most of these games are commercial games and toys. They are highly motivational and can break the classroom routines but should not simply be used to occupy children's time. As mathematics learning tools, games should be used purposefully. Initially, all activities, games, software, or equipment must be teacher/parent directed and goal oriented. The involvement of the teacher/parent is essential for success and progress.

Engaging all children in a single game assumes that there are no individual differences among children, parents, or teachers. The key to the wise use of games and toys is first to determine what prerequisite skills the child needs and then to select the appropriate games and toys.

The **Number War Games**, a collection of games, which I designed based on the popular *game of war* using ordinary deck of cards to teach number and number relationships is very useful for developing arithmetic skills. These games use ordinary decks of playing cards and Dominos—a versatile set of tools for teaching mathematics from number conceptualization to introductory algebra. It is better to play these games with cards that do not have numbers on them. (*Cards without numbers on them are available from the Center.*)

One of the most popular games American children play is the Game of War. Number War Games begin in the same way as the Game of War. They are played essentially the same way and are easy to learn. I call them The Number War Games because they are based on this popular game. To avoid the word war, you can call it by some other name such as: “beat it” or “top it.” Children love to play these games. I have successfully used them for initial as well as remedial instruction, particularly for learning number facts, fractions, integers and even algebra.

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