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The Use Of Mathematical Games In Teaching Primary Mathematics

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Abstract

Teachers often ignore the instructional values of games. They tend to use games in class to 'fill time' or to let children have some fun. The purpose of this paper is to distinguish mathematical games from other popular games and examine the instructional values of mathematical games. This paper explains how different versions of the game **"Cover Up"** can be constructed and used for introducing the addition and substraction of related fractions to children.

Introduction

Children enjoy playing games and often equate games with fun. Teachers of primary mathematics can capitalise on this fact and design instructional games to motivate children to learn. A well designed mathematical game can have both affective and cognitive effects on learning mathematics. Ernest (1986), in his argument for the use of games as a means for teaching mathematics, pointed out that games can be used to teach mathematics effectively by providing reinforcement and practice of skills, by providing motivation, by helping in the acquisition and development of concepts, and by developing problem solving strategies. According to Ainley (1988), not all games have these instructional values. She believes that only those games in which *both* the structures and the rules of the games are based on mathematical ideas are effective instructional tools. She refers to these games as true mathematical games and to win in these games, children need to understand the underlying mathematics. These are games that enable children to learn mathematics as well as provide opportunities for them to do real mathematics. Ainley defines real mathematics as "... mathematics which is important and meaningful to children, and doing what real mathematicians do, using mathematical processes and thinking in a mathematical way" (p.245).

Types of Mathematical Games

Games that have mathematical content or involve mathematical processes are not necessarily mathematical games. For example, the games of Monopoly and Scrabble involve computation and strategies of maximising the scores, but they are not essentially mathematical games and have little instructional value.

A mathematical game has the following desirable characteristics:

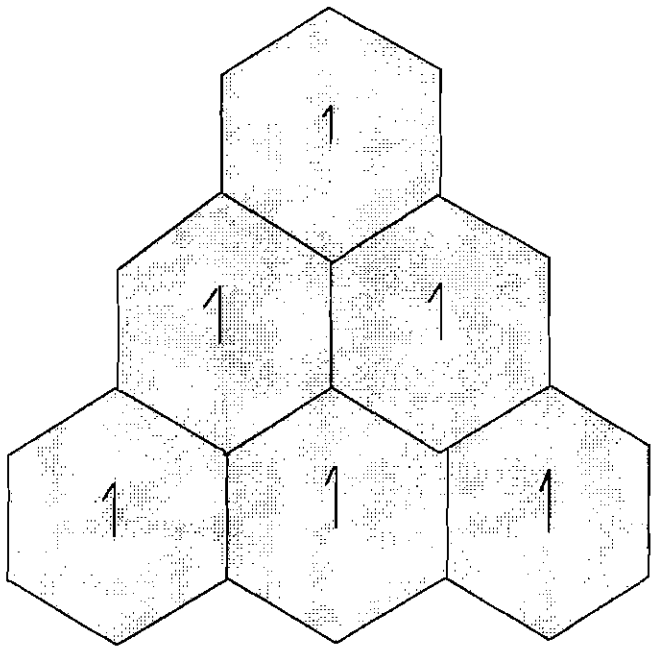
- The game is a challenge against one or more opponents.
- The game has a goal and the players have to make a finite number of moves to reach the goal stated. Each move is the result of a decision made.
- There is a set of rules that governs decision making.
- The rules are based on mathematical ideas.
- The game ends when the goal is reached.

There are two broad categories of mathematical games that may be played in the classroom. One category of games requires an external arbiter to determine whether the response is 'right' or 'wrong'. The arbiter may be electronic or human. Many computer games designed for practising mathematical skills are of this category. The other category of mathematical games possesses structure that allows the players themselves to check and correct errors with ease. The following is an example of a game in this category.

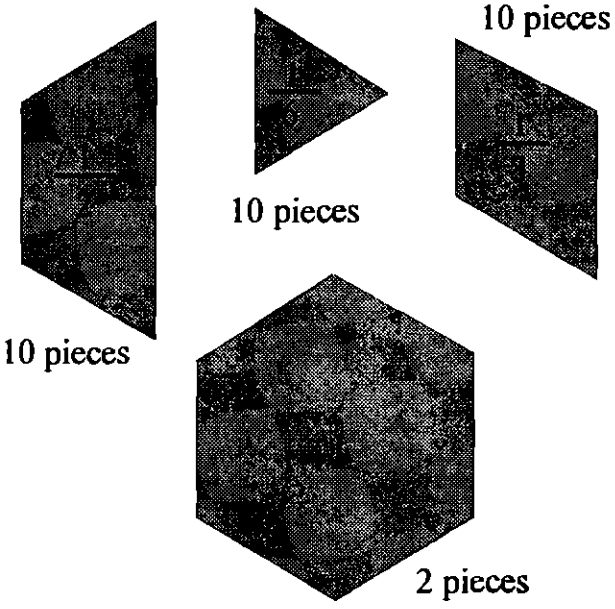
"Cover Up"

This is a game for introducing the addition of related fractions. Using this game, children's part-whole concept of fractions and concept of equivalent fractions will be reinforced. Here, children use what they have already known about fractions to explore and experiment about the addition of related fractions. To construct this game, you will need a spinner, a game board for each pair of players, and a set of fraction pieces for each player. Each set of fraction pieces consists of regular hexagons, equilateral triangles, rhombuses and isosceles trapeziums representing 1, 1/6, 1/3, 1/2 respectively. Each player should have a different coloured set of fraction pieces.

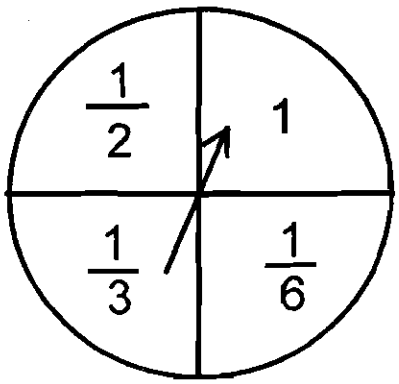
Game board
(1 for each pair of players)



A set of fraction pieces



Spinner



(a different coloured set for each player)

Figure. 1 Materials for **"Cover Up"**.

In this game, players take turns to spin the spinner and pick from their own set of fraction pieces, the fraction piece that represents the fraction indicated on the spinner. On each turn, the players will select an additional piece to place on the

game board. To provide practice in equivalent fractions, a player is allowed to exchange two or more of his *adjacent* fraction pieces on the game board for an equivalent fraction piece (Figure 2). Once a fraction piece is placed on the game card, it cannot be moved unless for 'exchanging' purposes.

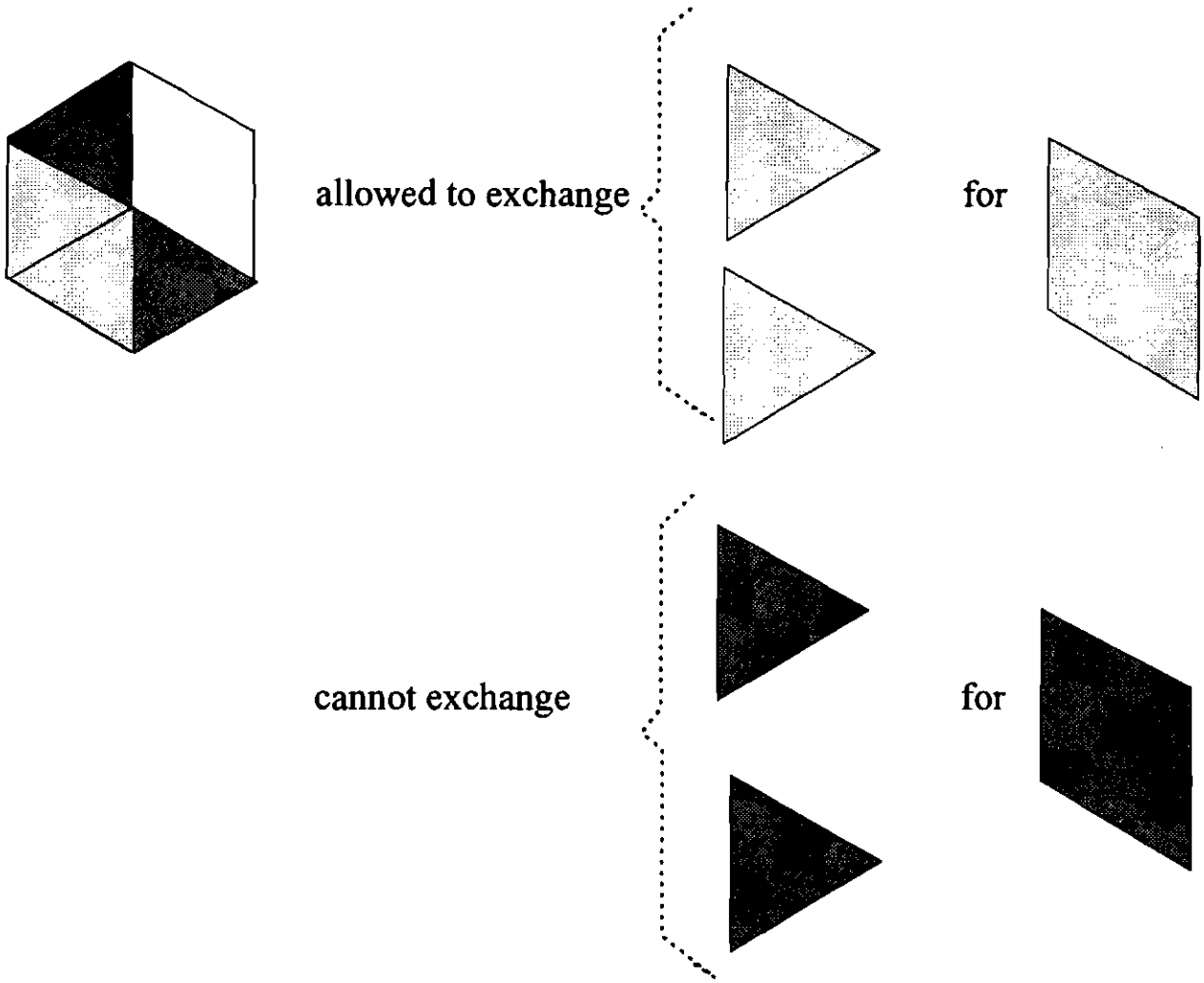


Figure 2.

Once the game board has been completely covered, the player who has used his fraction pieces to cover up a larger area on the game board is the winner. If there is a tie, then the player who has used the minimum number of fraction pieces will be declared the winner. In this game, every action of the players, when challenged, can be checked and corrected by comparing the fraction pieces.

Children are also required to record their actions in their game cards (Figure 3). The teacher can check the children's actions by examining their game cards. Misconceptions and errors can be identified. The addition sentences on the game cards can later be used for class discussion on the addition of related fractions.

MY GAME CARD

Name : *Jane Lim* Class : *P4B*

Round	Fraction pieces picked	My Addition Sentence	Fraction pieces exchanged
1	a triangle	0 + 1/6 = 1/6	none
2	a rhombus	1/6 + 1/3 = 1/2	all for a trapezium
3	a triangle	1/2 + 1/6 = 2/3	

Final sum = _____

No. of fraction pieces used = _____

Figure 3.

This game may be simplified or extended. A simpler version (Figure 4) of the game involves a game board with a large equilateral triangle (representing 4), sets of fraction pieces consisting of small equilateral triangles (representing 1/4), rhombuses (representing 1/2) and medium-sized traingles (representing 1).

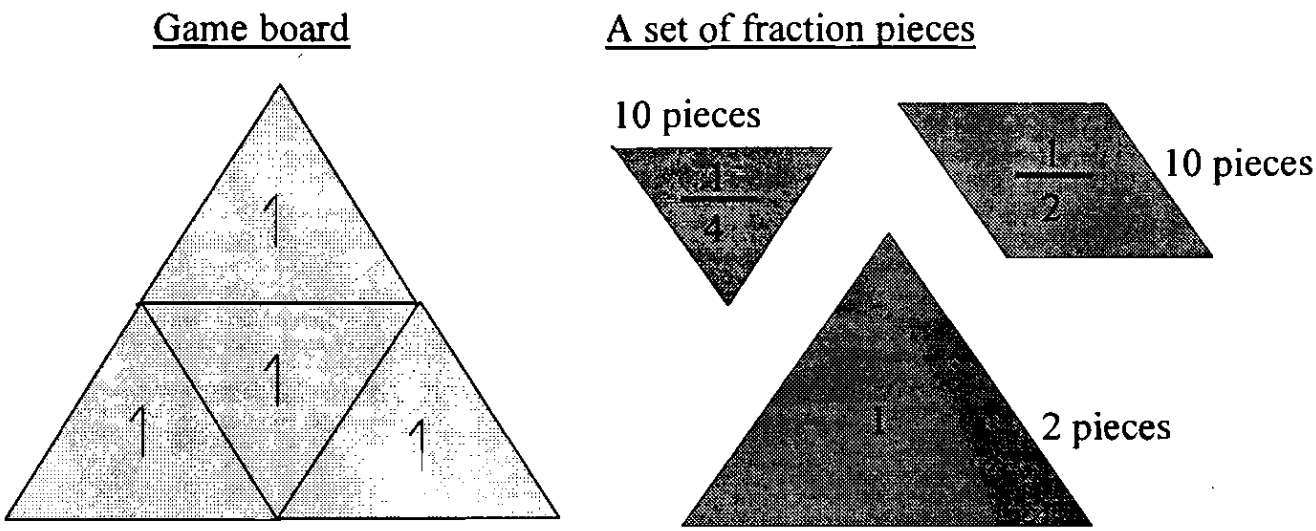


Figure 4.

Another version (Figure 5) of the game involves a game board with four squares joined along the edge (representing 4), sets of fraction pieces consisting of small isosceles right-angled triangles (representing 1/8), small squares (representing 1/4), rectangles (representing 1/2) and medium-sized squares (representing 1).

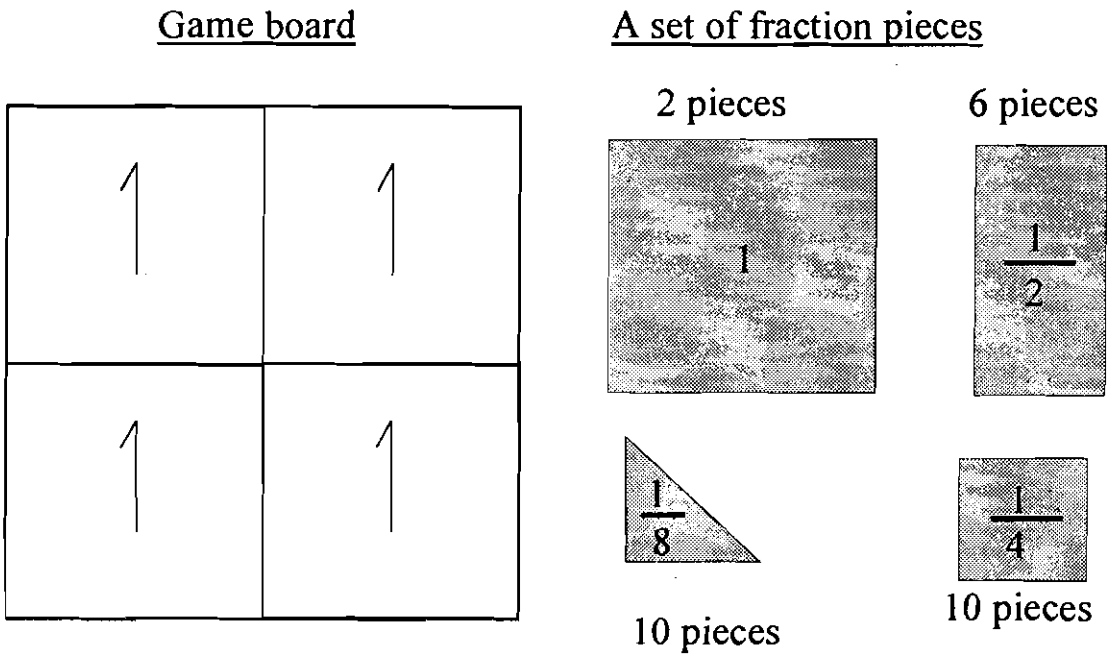


Figure 5.

Instead of using different polygons with different sets of related fractions, the game rule may be modified for subtraction of fractions. The players may begin with a covered game board, use the spinner to choose a fraction, and remove the corresponding fraction piece from the board. The winner is the player who has removed a larger section of the game board.

The Use of Mathematical Games in the Classroom

"Cover Up" is an example of a mathematical game that can simultaneously provide children with practice in acquired skills and exposure to new learning. Even though mathematical games can remove drudgery from the learning situation, teachers should incorporate mathematical games into their instructional programmes and not use games as 'time-filler' or to provide an enjoyable interlude in learning. Teachers should also not use games to provide a 'breathing space' for themselves in teaching. When using mathematical games in class, teachers should join in the games or move around and observe the children at play. They may ask questions to probe children's thought processes and understand their thinking strategies.

Besides stimulating mathematical thinking, another role for the teacher is to monitor children's learning. To do so, an annotated class list can be kept (Table 1). It is certainly impractical for a teacher to record comments on every child at play. Hence, only significant events are written down on the class list. Teachers would find such a list useful for keeping track of children's understanding of certain concepts and algorithms. The following is an example of an annotated class list for the game **"Cover Up"**.

Table 1. An Annotated Classlist for The Game **"Cover Up"**.

Annotated Class List (Class : P4B)

Game: Cover Up

Name	Comments	Action Required	Action Taken
Ali Ahmad	Exchange fraction pieces incorrectly	yes	
Mary Chan	Always first to spot peer errors		
Jane Lim	Thought 1/3 is larger than 1/2	yes	yes

As most children love to play mathematical games and games have a strong motivational effect, teachers should not use games as a reward for those children who have finished their class work, or else children may consider playing games as 'having fun' and not doing mathematics. Moreover, children who need to be motivated to learn mathematics are not getting it while those who need least motivation are getting it.

In addition to developing concepts and providing practice and motivation, games can also be used to help children develop thinking skills. Games promote problem solving. To attain this objective, teachers should select mathematical games that have problems imbedded in them so that children can improve their solution strategies by thinking mathematically. For example, in **"Cover Up"**, there are several places to place a fraction piece on the game board and children have to predict which place is 'the best'. They have to make conjectures and try out different strategies if the previous one does not work. Unlike a paper-and-pencil task, once a move has been made in the game, it cannot be undone.

Typically, children would become more cautious in the game situation and are more likely to check every conjecture and consequence since their opponent's move would have an effect on their position.

Games are also useful for promoting creativity. When children learn mathematics, they are often required to complete exercises set by their teachers or those found in their textbooks. There is no opportunity for them to create their own practice exercises. In the context of games, children can be encouraged to create their own games using the existing game structures. They can do so by using other types of numbers (e.g., decimals instead of fractions) or operations (e.g., addition instead of subtraction) and modifying the rules to simplify the game or to make the game more complex. Children can then exchange their games and play them.

Playing games can also help children develop social skills. When children play games cooperatively, they would have opportunities to listen to others as they share ideas and clarify their thinking. A child will certainly learn to conform and behave in a civilised way if he is to find other children willing to play with him. Hence, the teacher can modify games into games for teams and have mixed-ability groups play games together. Children are usually competitive in nature and there is a strong incentive for players to check one another's mathematics and challenge moves that they think are not valid. The teacher should promote this aspect of playing games as it provides a meaningful context for children to discuss and communicate mathematics. In addition, the teacher should conclude all game sessions with a discussion in which children are encouraged to express their strategies and justify the rules used. Any underlying misconception can then be identified and subjected to peer discussion. The teacher may follow the discussion with a worksheet to consolidate the understanding gained.

Conclusion

Games, if selected carefully on the basis of the instructional objectives and incorporated into the instructional programme, can enhance teaching and learning. In addition, through the dynamic interplay between the cooperative and competitive learning situations, games can be used to help children develop social skills. Hence, mathematical games do have a part to play in primary mathematics education and teachers should try to include games in their primary mathematics lessons.

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