Procedures for designing your own metric games for pupil involvement

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Although much has been written on the values of mathematical games in the elementary grades and many game books have been published, little has been written that would help classroom teachers design, produce, and evaluate games for use in their classroom. The focus of this article is to present a set of seven criteria that were developed in a summer workshop for inservice elementary teachers who decided that they wanted to be able to produce metric games and related activities that would fit into their "metrication" program.

The teachers in the workshop began by asking a practical question: Why should I be interested in producing my own metric games? They concluded that the game format provided them with specific activities for pupils who did not respond to the more typical patterns of instruction. They felt that in the game format they could provide activities of a higher cognitive level for pupils who had difficulty responding to material requiring advanced reading skills.

The teachers then asked a second question: Does the literature on the use of mathematics games contain any evidence that would encourage busy classroom teachers to use planning time to develop their own games? The available professional opinion supported the following conclusions:

1. Games can be used with modest success with verbally unskilled and emotionally disturbed students, and students for whom English is a second language.

2. Games have helped some teachers deal with students who present discipline problems because they are bored with the regular classroom routine.

3. Games seem to fit well into classrooms where the laboratory or learning-center approach is used. This seems related to the feature that games can be operated independent of direct teacher control thus freeing the teacher to observe and provide individual pupils with assistance on the same or related content.

Plan for development

If for any of the reasons just cited you are interested in designing and evaluating several of your own metric games, how should you begin? Simply use the following checklist as a step-by-step guide to help you generate the materials needed to create your game. Use the exemplar that follows the checklist as a source for more detailed

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suggestions. Each item in the checklist has been keyed to the exemplar to facilitate cross referencing.

CHECKLIST GUIDE

___ Write down what you want your students to learn from playing your game. (Establish specific outcomes)

___ Develop the materials required to play the game. (Make simple materials)

___ Develop the rules and procedures needed to tell each player how to participate in the game. (Write simple rules and procedures)

___ Decide how you want students to obtain knowledge of results. (Provide immediate feedback)

___ Create some way for chance to enter into the playing of the game. (Build in some suspense)

___ Pick out the features that can be easily changed to vary the focus or rules of the game. (Create the materials to allow variation)

___ Find out what the students think of the game and decide whether they learned what you intended them to learn. (Evaluate the game)

The exemplar

Establish specific outcomes

By carefully choosing objectives that involve both mathematics and science processes—such as observing, measuring, and classifying—the teachers created a game that involves players in the integrated activities. This approach reinforces the philosophy that science and mathematics can be taught together when the activities are mutually beneficial. That is, in many instances integrated activities can be used to conserve instructional time and to promote the transfer of process skills from one subject area to the other. The exemplar's objectives are labeled to show their relationship to science and mathematical processes.

1. Given a set of common objects, the students estimate the objects' weight correct to the nearest kilogram. (Observation and estimation)

2. Given an equal-arm balance, the students weigh and record the weights of common objects correct to the nearest centigram. (Measurement)

3. Given an object's estimated and observed weight correct to the nearest centigram, the student computes the amount over or under his estimate. (Computation and number relationships)

Make simple materials

The following materials were constructed or assembled to help students attain the objectives previously stated in an interesting and challenging manner.

1. Sets of 3-by-5 cards with tasks given on the front and correct answers and points to be scored on the back. (See fig. 1.)

2. A cardboard track (see fig. 2) made from oak tag. Shuffle the *E*'s (estimate cards), *O*'s (observed cards), and the *D*'s (difference cards) and place them on the gameboard in the places indicated.

3. An equal-arm balance that can weigh objects up to 7 kilograms.

4. A pair of dice and one different colored button per player.

5. A set of common objects that weigh less than 7 kilograms and more than 1 kilogram.

6. Student record card. (See fig. 3.)

Write simple rules and procedures

The rules and procedures are crucial to making a game self-instructional. In the following set of directions notice how a student leader and an answer card deck serve to ease the answer processing needed to keep the game moving smoothly from one player to another. It is essential to keep the rules simple and straightforward so that play moves quickly from one student to the other.

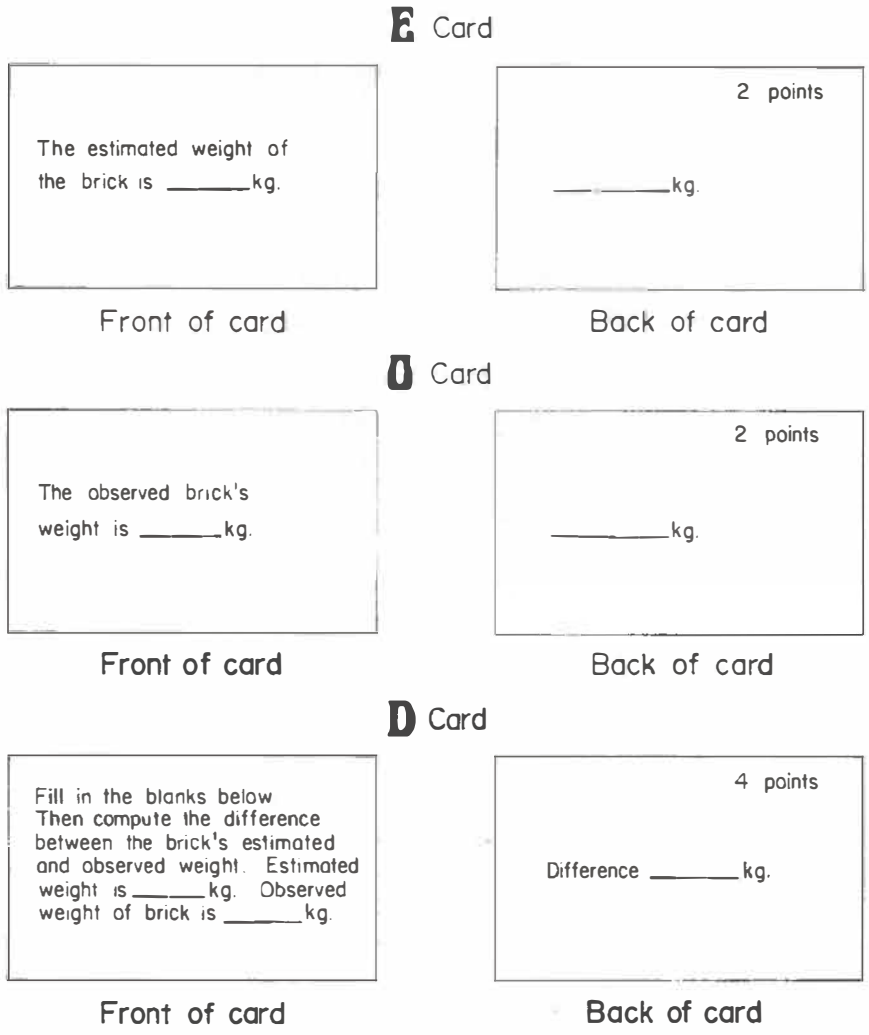

Fig. 1

1. Number of players, two to six.

2. The student leader or teacher aide begins by rolling the dice.

The highest roll goes first. All players start with their buttons in the "Start Here" block. The first player rolls one die and moves his button the number of spaces indicated on the die. If he lands on a space containing an *E*, *O*, or *D* he must choose the top card in the appropriate deck located in the center of the playing board or track and perform the task indicated. (In the example shown in figure 1 this would be Card E_3.)

The player then records the card number, his answer, and the points awarded by the student leader on his record card. The student leader checks each player's answer and awards the appropriate number of points by reading the back side on the task card. He then places that card on the bottom of the appropriate deck and play moves to the right of the first player. The player who reaches "Home" square with the highest number of points is the winner. At the end of the play each player turns in his score card to the student leader who gives them to the teacher.

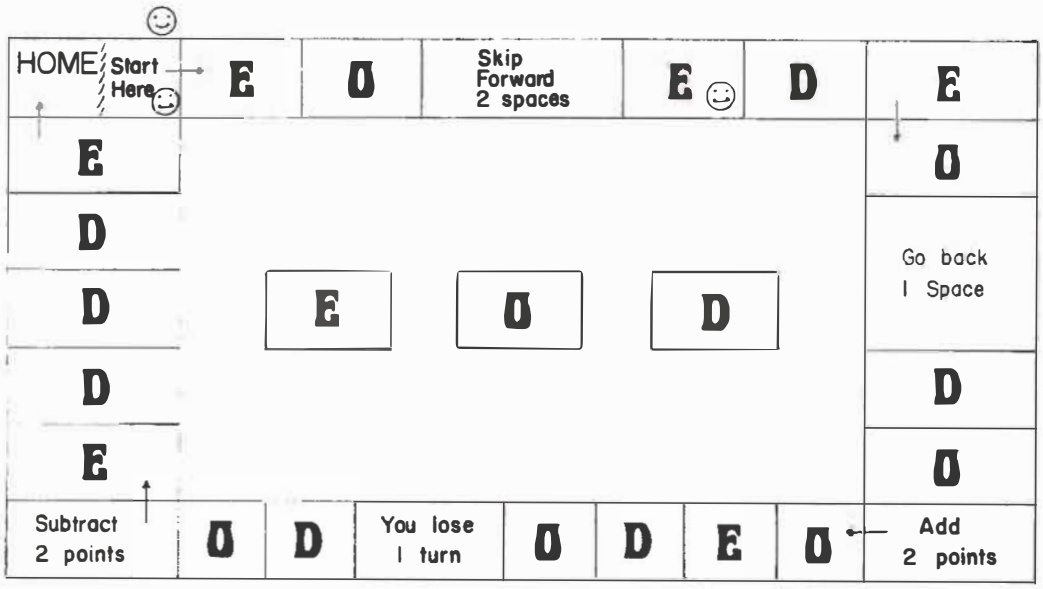

Fig. 2

Provide immediate feedback

By placing the answer on the back of the task card and appointing a student leader, the teacher who developed this game built into the game an important characteristic, immediate knowledge of the results of each player's performance. In most cases this feedback feature can be built into a game—by using the back of task cards, by creating an answer deck, or by using a student leader whose level of performance would permit him to judge the adequacy of other students' performance in a reliable manner. Feedback is one of the key features of an instructional game because it has motivational as well as instructional impact.

Have students record diagnostic information. The student record card is an important feature of the game. The cards help the teacher to judge when the difficulty of the task card should be altered and which players should play together in a game, and to designate student leaders for succeeding games. The card also provides the player with a record that shows his scores and motivates him to improve.

This evaluative feature can be built into most games by using an individual record card, by having the student leader pile cards yielding right answers in one pile and cards with wrong answers in another pile, or by having the student leader record the results of each play on a class record sheet.

Build in some suspense

Experience has shown that games enjoyed by students contain some element of risk or chance. In this particular game a player gets a task card based upon the roll of the die. He also has the possibility of being skipped forward or skipped back spaces, or of losing his turn. Skipping back builds in the possibility of getting additional opportunities to score points; this feature helps low-scoring students catch up. Skipping forward cuts the number of opportunities a high-scoring player has to accumulate points. The possibility of adding or subtracting points also helps create some suspense. These suspense-creating features help make the game what the students call "a fun game."

Student's name _____ Date_____

Card number	Answer given	Number of points
E_3	2 kg.	2
E_2	1 kg.	1

Fig. 3

Create the materials to allow variation

A game that has the potential for variation with minor modifications of the rules or materials has at least two advantages. First, it allows a new game to be created without a large time investment on the part of the teacher. Second, it keeps the game from becoming stale because the students know all the answers. For instance, the exemplar game can be quickly changed by making new task cards that require that students estimate and measure the area of common surfaces found in the classroom such as a desk or table tops. By combining the two decks mixed practice could be provided.

Evaluate the game

Try the game and variations with a small group of students and observe their actions. Use the first-round record cards as a pretest. Keep the succeeding record cards for each student in correct order. By comparing the last-round record cards with the first-round record cards for a specific student, you can keep track of the progress a particular student is making. Filing the cards by student names will provide a longitudinal record of a student's progress for a given skill as well as diagnostic information for future instruction.

Finally, decide whether the students enjoy the game. The best way is to use a self-report form containing several single questions like the following, which can be answered in an interview or in writing:

1. Would you recommend the game to someone else in the class? __Yes __No

2. Which face indicates how you felt when you were playing the game?

3. What part of the game did you like best?

4. How would you improve the game?

Concluding remarks

The procedure just illustrated can be generalized to other topics in science and mathematics. The following list provides some suggested topics.

1. Classifying objects measured in metric units by weight and shape
2. Measuring volume and weight with metric instruments
3. Measuring length and area with metric instruments
4. Classifying objects measured in metric units by size and shape
5. Comparing the weight of a liquid to its volume
6. Comparing the weight of a liquid with the weight of an equal volume of water
7. Predicting what will happen to a block on an inclined plane
8. Comparing the weights of different metals of equal volume

Why don't you try and create some games for each of these topics? Then share the results with your colleagues. Additional examples developed by the authors are available in "Metric Games and Bulletin Boards" in *The Instructor Handbook Series* No. 319 (Dansville, New York, 1973). ■