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ABSTRACT

The current period in mathematics education can be characterized as one of reform. Among the goals of the proponents of the movement are that children learn to value mathematics, become confident in their ability, and become mathematical problem solvers. A pretest/posttest experimental design study examined the effects of SQUARE ONE TV, a television series about mathematics aimed at 8- to 12-year-old children, on the problem-solving behavior and attitudes toward mathematics of 240 fifth graders from 4 public schools in Corpus Christi, Texas. Attitude data was collected from a subgroup of 24 students exposed to 30 SQUARE ONE TV programs and from 24 students in a control group having no SQUARE ONE TV contact. Presented in this paper are the results of the study on problem-solving behavior. The viewers showed significantly greater improvement than nonviewers both in their use of problem-solving actions and heuristics and in the solutions they reached. The series of programs exerted equal effects across the variables of sex, ethnicity, and socioeconomic backgrounds. The results indicate that: (1) educational materials developed for specific goals can be effective; (2) children's problem-solving skills can be assessed; and (3) SQUARE ONE TV can play a significant role in the effort toward reform. (MDH)

SQUARE ONE TV: Using television to enhance children's problem solving

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Children's Television Workshop

Paper presented in symposium entitled "Problem solving, attitudes, and television: A summative study of **SQUARE ONE TV**" (Eve R. Hall and Shalom M. Fisch, chairs) at the biennial meeting of the Society for Research in Child Development, Seattle, WA.

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The current period in mathematics education can be characterized as one of reform. There is widespread dissatisfaction among professionals and laypeople alike with the present state of mathematics learning among children in the United States (Hill, 1987; McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987; National Assessment of Educational Progress, 1988; National Council of Teachers of Mathematics, 1989; National Research Council, 1989, 1990; Romberg, 1984); indeed, much of the literature refers to the deficiencies that currently exist as a "crisis" in mathematics education. Many feel that children in the United States are not learning enough of the mathematics that will be appropriate for the coming decades, and that children's conceptions of the nature and uses of mathematics are inaccurate and misinformed.

At the forefront of the movement toward reform are two professional organizations, the National Council of Teachers of Mathematics (NCTM) and the Mathematical Sciences Education Board (MSEB). The MSEB reports Everybody Counts (National Research Council, 1989) and Reshaping School Mathematics: A Philosophy and Framework for Change (National Research Council, 1990) detail the problems affecting U.S. mathematics education and provide an overall conceptualization of what needs to be done. At the same time, in its Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), NCTM has identified goals for elementary students studying mathematics. Among these goals are that they learn to value mathematics, become confident in their ability, become mathematical problem solvers, and learn to communicate and reason mathematically.

In an attempt to contribute to this reform movement, Children's Television Workshop has created Square One TV. Square One TV is a television series about mathematics, aimed at an audience of 8- to 12-year-old children, primarily watching at home (although some stations carry the series during school hours). Each program is one-half hour in length, and employs what is called a "magazine" format, in which a variety of discrete segments constitute an entire program. The series is humorous, and the majority of segments parody television styles and conventions familiar to children. Several types of segments are used: studio sketches (featuring a seven-player repertory company), game shows, short films, music videos, and animation. Each program of Square One TV ends with an installment of "Mathnet" (a serialized parody of the detective series "Dragnet"), in which two mathematicians use mathematical problem solving to solve crimes. At the time of this writing, three seasons of **SQUARE ONE TV** have been produced, resulting in a total of 155 programs. A fourth season (consisting of 40 programs) is currently in production.

The series has three main goals:

I. To promote positive attitudes toward, and enthusiasm for, mathematics;

II. To encourage the use and application of problem-solving processes; and

III. To present sound mathematical content in an interesting, accessible and meaningful manner.

Each of these goals is refined into a range of subgoals; the complete breakdown is fully explicated in the goals statement presented in Appendix 1.

In emphasizing the importance of encouraging problem solving and positive attitudes toward mathematics, the goals of Square One TV are consonant with those of NCTM, thus indicating an underlying philosophy that is in keeping with the ongoing reform movement in mathematics education. As result, a natural question that arises -- not only for the producers of the series but also for anyone interested in educational reform -- is the degree to which regular viewers are affected by material directed toward these goals.

An earlier CTW study (Peel, Rockwell, Esty, & Gonzer, 1987) found that children in the target age group could recall and comprehend the mathematical content presented in a sample of Season I segments, and that in many cases, they could extend that information to new, but related, problem situations. The study also probed for the children's interpretations of the characters' feelings or attitudes toward the mathematical situations in which they found themselves. However, that study was not designed to provide a thorough investigation of the children's own attitudes toward mathematics or their abilities to apply the problem-solving processes shown on Square One TV to novel problem situations.

The present study was a natural outgrowth of that work. Its purpose was to address Goals I and II directly by examining in great detail the changes that might occur in children's problem-solving behavior and attitudes toward mathematics as a result of viewing Square One TV. In this paper, we will present a brief description of the portion of the study concerned with problem solving; further details on this portion of the study can be found in Esty, Hall, and Fisch (1990). The reader is referred to Debold, Hall, Fisch, Bennett, and Solan (1990) for a detailed account of the portion of the study concerning attitudes.

Method

Subjects and Procedure

Fifth graders in four public elementary schools in Corpus Christi, TX, participated in the study. This site was selected because Square One TV had not been part of the local after-school broadcast schedule prior to the completion of data collection, and it had not been shown in school. Each of the schools provided a standard, district-wide mathematics program using a popular mathematics textbook.

Over an eight-week period, the children in two of the schools (the "viewer" group) were shown 30 episodes of Square One TV. Although these episodes were shown in school, teachers did not incorporate them into their lessons and did not comment upon them in any way; thus, the children's exposure to the series consisted of sustained, unaided viewing in a group setting. The two control schools (the "nonviewer" group) did not see Square One TV at all; their schedule did not change from what it normally was.

Forty-eight children (24 from each group), matched for sex, socioeconomic status (SES), ethnicity, and performance on a standardized mathematics test, were tested before and after the eight-week viewing period in an experimental pretest/posttest design. One half of the children were boys and one half were girls; 67% were Latino, 4% were African-American, and 29% were Anglo (these percentages mirrored those of the school system as a whole).

Problem solving was tested via several hands-on, nonroutine mathematical Problem-Solving Activities (PSAs), each of which could be solved through a number of approaches. The three PSAs represented a range of complexity. The least complex problems (PSAs A and A') were combinatorics problems involving orders of stripes on a shirt or of circus performers. PSAs B and B' (which were of medium complexity) asked children to sort cards representing party guests or price tags into groups meeting several conditions. PSAs C and C', the most complex problems, presented children with a mathematical game and asked them to figure out what was wrong with the game and how to fix it (see Appendix 2 for an example of one of these problems). Children received one set of PSAs (either A, B, and C or A', B', and C') at the pretest and the other set at the posttest. (For the purposes of this document, we refer to the pair of PSAs A and A', for example, as PSA A*.)

Both at the pretest and at the posttest, each child was tested individually in two 55-minute sessions, the first consisting of two PSAs and the second containing the third PSA, embedded in an approximately 40-minute Attitude Interview. The CTW interviewers and coders were blind to the children's viewer/nonviewer status; that is, they did not know which children were viewers and which were not. Similarly, the children did not know of the interviewers' connection to Square One TV.

Overview of Results

For each of the three PSAs, each child was scored on two measures: (1) the number and variety of problem-solving actions and heuristics used (the P-score[1]), and (2) the mathematical completeness and sophistication of the solution reached (the M-score). These two scores are conceptually independent in the sense that a child's use of a large number of problem-solving actions or heuristics would not necessarily lead to a sophisticated or complete solution; and, conversely, a sophisticated and complete solution might be obtained despite a child's use of a very limited problem-solving repertoire.

P-scores

From pretest to posttest, children in the viewing group made significantly greater P-score gains on each of the three PSAs than the nonviewers did. (Two-way ANOVAs showed interactions of pre/post with viewer/nonviewer to be significant at the $p < .001$ level for PSAs A*, B*, and C*.) The viewers' pretest to posttest gains were significant ($p < .001$ for PSA A* and C*; $p < .01$ for PSA B*); the nonviewers did not make significant gains. Further, in each PSA there was a significant P-score difference at the posttest between the viewers and nonviewers ($p < .001$ in each case).

Fig. 1 about here

Figure 1 shows the combined[2] mean P-scores of the two groups at the pretest and posttest, with an interval of one standard deviation above and below each mean. It is clear from Figure 1 that there was substantial overlap between the viewers' and nonviewers' P-scores at the pretest. At the posttest, however, the viewers' P-scores increased significantly, while the nonviewers' did not.[3] At the posttest, then, there was much less overlap between the two groups.

M-scores

From pretest to posttest, children in the viewing group made significantly greater M-score gains than nonviewers on two of the three PSAs. (Two-way ANOVAs showed interactions of pre/post with viewer/nonviewer on PSA A* ($p < .01$) and PSA C* ($p < .001$).) From pretest to posttest, the viewers' M-scores increased significantly on PSAs A* and C* ($p < .001$). Further, the difference between the two groups at the posttest was significant in PSA C* ($p < .001$) and marginal in PSA A* ($p < .10$).[4]

Figure 2 shows the mean total[5] M-scores of the two groups at the pretest and the posttest, with an interval of one standard deviation above and below each mean.

Fig. 2 about here

The same pattern observed for P-scores is apparent here: At the pretest there was substantial overlap between the two groups. However, at the posttest the viewing group's M-scores were significantly higher, resulting in much less overlap. The nonviewers' M-scores did not change significantly from pretest to posttest on any of the PSAs.

Relationship between P-scores and M-scores

Even though the P- and M-scores are conceptually independent, in this sample they were significantly correlated ($r = .52$; $p < .001$); higher P-scores tended to be associated with higher M-scores. A model-fitting analysis, detailed in Esty, Hall, and Fisch (1990), indicated that while the series exerted direct effects on both P-scores and M-scores, its effect on the children's M-scores was also, in part, mediated by its effect on P-scores. That is, exposure to Square One TV resulted in the children's using an increased number and variety of problem-solving behaviors, which in turn led them to reach more complete and sophisticated solutions.

Effects of Sex, SES, and Ethnicity

There were no significant sex differences in children's M-scores at either the pretest or the posttest. Further, the changes in children's M-score performance from pretest to posttest did not interact significantly with their sex.

Similarly, sex did not have a significant main effect on children's P-scores. Both boys and girls who watched Square One TV improved significantly ($p < .01$) from pretest to posttest, and there was no difference between boys and girls in the viewing group at either the pretest or the posttest.[6] Thus, it appears that Square One TV had a similar effect on the boys and girls in the viewing group.

Middle-SES children received higher P-scores than low-SES children did ($p < .01$), and higher M-scores on two of the three PSAs ($p < .01$ for PSA A*; $p < .05$ for PSA C*). But, as in the case of sex, the changes in children's P-scores and M-scores did not interact significantly with SES, indicating that Square One TV exerted a similar effect on the low- and middle-SES children in this sample.

In this study, minority children were largely of lower SES, and nonminority children were of middle SES. Thus a pattern similar to the one found for SES emerged when the data were analyzed by ethnicity. That is, nonminority children received higher P-scores than minority children ($p < .05$), and marginally higher M-scores in PSA C* ($p < .10$), but there was no significant interaction between ethnicity and the effects of Square One TV on either P-scores or M-scores. This indicates that Square One TV affected minority and nonminority children similarly.

Relationship to Standardized Test Scores

Ten months before the study started, school district personnel administered an annual standardized mathematics achievement test to all fifth graders in the district. The children's scores on this achievement test were not significantly correlated with their P-scores or M-scores on any of the PSAs. (The correlations between P-scores and standardized test scores range from -.18 to .11; the correlations between M-scores and standardized test scores range from -.07 to .02.)

Additional P-score Results

A set of more detailed analyses was carried out to explain the sources of the viewers' significantly increased P-scores. Some of the results, briefly, are these:

o A large percentage (an average of 42%) of the problem-solving actions and heuristics that the viewers used in the posttest were new, that is, actions that they had not used in the pretest. This proportion for viewers was significantly larger than the average of 25% observed for nonviewers ($p < .005$ for PSA A* and C*; $p < .10$ for PSA B*).

o For each of the PSAs, we tallied the number of problem-solving actions and heuristics for which there was an increased use from pretest to posttest. Averaged over the three PSAs, viewers increased in their use of 11.7 of the 17 actions and heuristics, while nonviewers increased in only 4.0 of the 17.

o A more fine-grained study was undertaken of the relationship between the Goal II content of the Square One TV programs in the treatment and viewers' subsequent use of particular problem-solving actions or heuristics. The situation here is complex because children's use of specific problem-solving actions or heuristics is a function of at least three factors: (1) the influence of Square One TV, (2) the behaviors that the children would bring to the problem normally, without any influence from Square One TV, and (3) the kinds of behavior that would be most appropriate to use on the particular problem. As a result, generalizations are difficult to make in this area. However, in many cases viewers (more than nonviewers) used particular problem-solving techniques that were especially appropriate or powerful in their solutions of certain PSAs.

Discussion

The results described above are quite striking when one considers that: (a) the viewers and nonviewers were carefully matched in the pretest and (b) the viewers' exposure to Square One TV took place without any further curricular enhancement. Viewers showed significantly greater improvement than nonviewers both in their use of problem-solving actions and heuristics and in the solutions they reached, despite the fact that the only difference in the experimental treatment of the two groups was that viewers were shown 30 programs of Square One TV. Moreover, the series exerted similar effects on boys and girls, and on children of different ethnic and SES backgrounds.

There are several ways in which these results are very encouraging for the reform movement in mathematics education. First, they provide a clear indication that material produced in response to the goals of the reform movement can have the desired impact on children's problem-solving behavior. Second, they illustrate the types of measures that can be used to assess children's performance on nonroutine problem-solving tasks, an issue that is of great concern if one is to implement mathematics curricula that are based on this type of problem solving. Finally, they demonstrate that Square One TV can play a significant role in the effort toward reform.

References

Debold, E., Hall, E.R., Fisch, S.M., Bennett, D.T., & Solan, S.V. (1990). Children's problem-solving behavior and their attitudes toward mathematics: A study of the effects of Square One TV (Vol. 3: Children's attitudes toward mathematics and the effects of Square One TV). New York: Children's Television Workshop.

Esty, E.T., Hall, E.R., & Fisch, S.M. (1990). Children's problem-solving behavior and their attitudes toward mathematics: A study of the effects of Square One TV (Vol. 2: The effects of Square One TV on children's problem solving). New York: Children's Television Workshop.

Hall, E.R., Esty, E.T., & Fisch, S.M. (1990). Television and children's problem-solving behavior: A synopsis of an evaluation of the effects of Square One TV. Journal of Mathematical Behavior, 9, 161-174.

Hill, S.A. (1987). National need: Mathematics education must undergo basic changes. National Research Council News Report, 37, 6, 17-18.

McKnight, C.C., Crosswhite, F.J., Dossey, J.A., Kifer, E., Swafford, J.O., Travers, K.J., & Cooney, T.J. (1987). The underachieving curriculum: Assessing U.S. school mathematics from an international perspective. Champaign, IL: Stipes Publishing Co.

National Assessment of Educational Progress. (1988). The mathematics report card: Are we measuring up? Princeton, NJ: Educational Testing Service.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

National Research Council. (1989). Everybody counts: A report to the nation on the future of mathematics education. Washington, DC: National Academy Press.

National Research Council. (1990). Reshaping school mathematics: A philosophy and framework for change. Washington, DC: National Academy Press.

Peel, T., Rockwell, A., Esty, E., and Gonzer, K. (1987). SQUARE ONE TELEVISION: The comprehension and problem solving study. New York: Children's Television Workshop.

Romberg, T.A. (1984). School mathematics: Options for the 1990s. Vol. 1. Chairman's report of a conference. Washington, DC: Office of the Assistant Secretary for Educational Research and Improvement.

Notes

1. The P-score incorporates 17 problem-solving actions and heuristics that are derived from the subgoals of Goals IIB, IIC and IID.

2. The pairwise correlations among P-scores for PSAs A*, B* and C* were all positive and significant at the $p < .01$ level, or even more significant. The combining of P-scores was done via principal components analysis.

3. The decline in the nonviewers' mean combined P-score is marginal ($p < .10$). The nonviewers' P-scores declined significantly in PSAs A* and B* ($p < .01$), but not in C*.

4. M-score changes in PSA B* were not significant for either group. Something akin to a ceiling effect appeared to be operating in the sophistication and completeness of children's solutions to this problem at both pretest and posttest. Thus there was little change from pretest to posttest.

5. For summary purposes only, the M-scores from the three PSAs were combined simply by adding them. The correlations among the M-scores for PSAs A*, B*, and C* were not all significant, so any combination of M-scores across the three PSAs should be interpreted with caution.

6. There was, however, a marginal ($p < .10$) three-way interaction among sex, condition and pretest/posttest; this was attributable to a drop ($p < .05$) from pretest to posttest in the nonviewing girls' P-scores.

Appendix 1

Elaboration of goals of

Square One TV

GOAL I. To promote positive attitudes toward, and enthusiasm for, mathematics by showing:

A. Mathematics is a powerful and widely applicable tool useful to solve problems, to illustrate concepts, and to increase efficiency.

B. Mathematics is beautiful and aesthetically pleasing.

C. Mathematics can be understood, used, and even invented, by non-specialists.

GOAL II. To encourage the use and application of problem-solving processes by modeling:

A. Problem Formulation

1. Recognize and state a problem.
2. Assess the value of solving a problem.
3. Assess the possibility of solving a problem.

B. Problem Treatment

1. Recall information.
2. Estimate or approximate.
3. Measure, gather data or check resources.
4. Calculate or manipulate (mentally or physically).
5. Consider probabilities.
6. Use trial-and-error or guess-and-check.

C. Problem-Solving Heuristics

1. Represent problem: scale model, drawing, map; picture; diagram, gadget; table, chart; graph; use object, act out.
2. Transform problem: reword, clarify; simplify; find subgoals, subproblems, work backwards.
3. Look for: patterns; missing information; distinctions in kind of information (pertinent or extraneous).
4. Reapproach problem: change point of view, reevaluate assumptions; generate new hypotheses.

D. Problem Follow-up

1. Discuss reasonableness of results and precision of results.
2. Look for alternative solutions.
3. Look for alternative ways to solve.
4. Look for, or extend to, related problems.

GOAL III. To present sound mathematical content in an interesting, accessible, and meaningful manner by exploring:

A. Numbers and Counting

1. Whole numbers.
2. Numeration: role and meaning of digits in whole numbers (place value); Roman numerals; palindromes; other bases.
3. Rational numbers: interpretations of fractions as numbers, ratios, parts of a whole or of a set.
4. Decimal notation: role and meaning of digits in decimal numeration.
5. Percents: uses; link to decimals and fractions.
6. Negative numbers: uses; relation to subtraction.

B. Arithmetic of Rational Numbers

1. Basic operations: addition, subtraction, division, multiplication, exponentiation; when and how to use operations.
2. Structure: primes, factors, and multiples.
3. Number theory: modular arithmetic (including parity); Diophantine equations; Fibonacci sequence; Pascal's triangle.
4. Approximation: rounding; bounds; approximate calculation; interpolation and extrapolation; estimation.
5. Ratios: use of ratios, rates, and proportions; relation to division; golden section.

C. Measurement

1. Units: systems (English, metric, non-standard); importance of standard units.
2. Spatial: length, area, volume, perimeter, and surface area.
3. Approximate nature: exact versus approximate, i.e., counting versus measuring; calculation with approximations; margin of error; propagation oferror; estimation.
4. Additivity.

D. Numerical Functions and Relations

1. Relations: order, inequalities, subset relations, additivity, infinite sets.
2. Functions: linear, quadratic, exponential; rules, patterns.
3. Equations: solution techniques (e.g., manipulation, guess-and-test); missing addend and factor; relation to construction of numbers.
4. Formulas: interpretation and evaluation; algebra as generalized arithmetic.

E. Combinatorics and Counting Techniques

1. Multiplication principle and decomposition.
2. Pigeonhole principle.

3. Systematic enumeration of cases.

F. Statistics and Probability

1. Basic quantification: counting; representation by rational numbers.
2. Derived measures: average, median, range.
3. Concepts: independence, correlation; "Law of Averages."
4. Prediction: relation to probability.
5. Data processing: collection and analysis.
6. Data presentation: graphs, charts, tables; construction and interpretation.

G. Geometry

1. Dimensionality: one, two, three, and four dimensions.
2. Rigid transformations: transformations in two and three dimensions; rotations, reflections, and translations; symmetry.
3. Tessellations: covering the plane and bounded regions; kaleidoscopes; role of symmetry; other surfaces.
4. Maps and models in scale: application of ratios.
5. Perspective: rudiments of drawing in perspective; representation of three-dimensional objects in two dimensions.
6. Geometrical objects: recognition; relations among; constructions; patterns.
7. Topological mappings and properties: invariants.

Appendix 2

This is a description of Problem-Solving Activity C' (PSA C'), which was used in Children's Television Workshop's summative evaluation of Square One TV.

In this PSA, the child is told about a person named Dr. Game, who owns a game factory. Dr. Game was recently dismayed to find that his factory had been broken into, and that some of his games had been changed in some way. The child has been hired by Dr. Game to find out what is wrong with one of these games.

The experimenter shows the child the equipment for the game, which consists of the following: two spinners, one numbered 3, 4, and 5, and the other numbered 2 and 6; a coin marked "+" on one side and "x" on the other; a number board with two elasticized loops -- one orange and the other green -- arranged so that the loops surround two sets of numbers; two stand-up, cut-out players, one of whom wears a sign around its neck saying "Orange" and the other with a sign saying "Green"; and nine plastic chips. The spinners, number board, and players are pictured in Figure 3.

The experimenter explains the rules of the game to the child. To play the game, a spinner-person (not identified further) spins both spinners, getting two numbers, and flips the coin, getting addition or multiplication. Then he or she does the addition or multiplication, and finds the answer on the board. If the answer is inside the green loop, then the Green player gets one chip; if the answer is inside the orange loop, then the Orange player gets one chip. Whoever has more chips at the end of nine spins wins the game.

After the child is reminded that something is wrong with the game and that the task is to find out what is wrong, the experimenter leaves the child to work alone. A kit of materials (paper, pencils, pens, a calculator, a ruler, a protractor, and some circular stickers) is available for the child to use if he or she wants to.

[What is wrong with the game is that it is unfair to Green. The probability of awarding each chip to Orange is .75, and the probability of Orange's winning more chips than Green by the end of the game is more than .95.]

When the child has told the experimenter what he or she thinks is wring with the game, the experimenter asks several standardized questions that encourage the child to describe his or her actions, thoughts, and strategies. Then the next task is posed: to fix the game.

[The game can be fixed (or at least made fairer than it is) in a variety of ways: by moving the orange and green loops appropriately; by changing some or all of the numbers on the spinners; by changing the operations on the coin; by awarding more than one chip to Green if the answer is in the green loop; or by some combination of these.]

Again, the child is left alone to work on this. The experimenter returns to the table when summoned or if the child seems not to be working productively any longer. As before, the experimenter uses a set of carefully structured probe questions to get at what the child was doing and thinking during the period he or she was working on the problem.

Figure 1. Mean P-scores (all PSAs combined) for Viewers and Nonviewers in Pre- and Posttest with 1 SD above and below the mean.

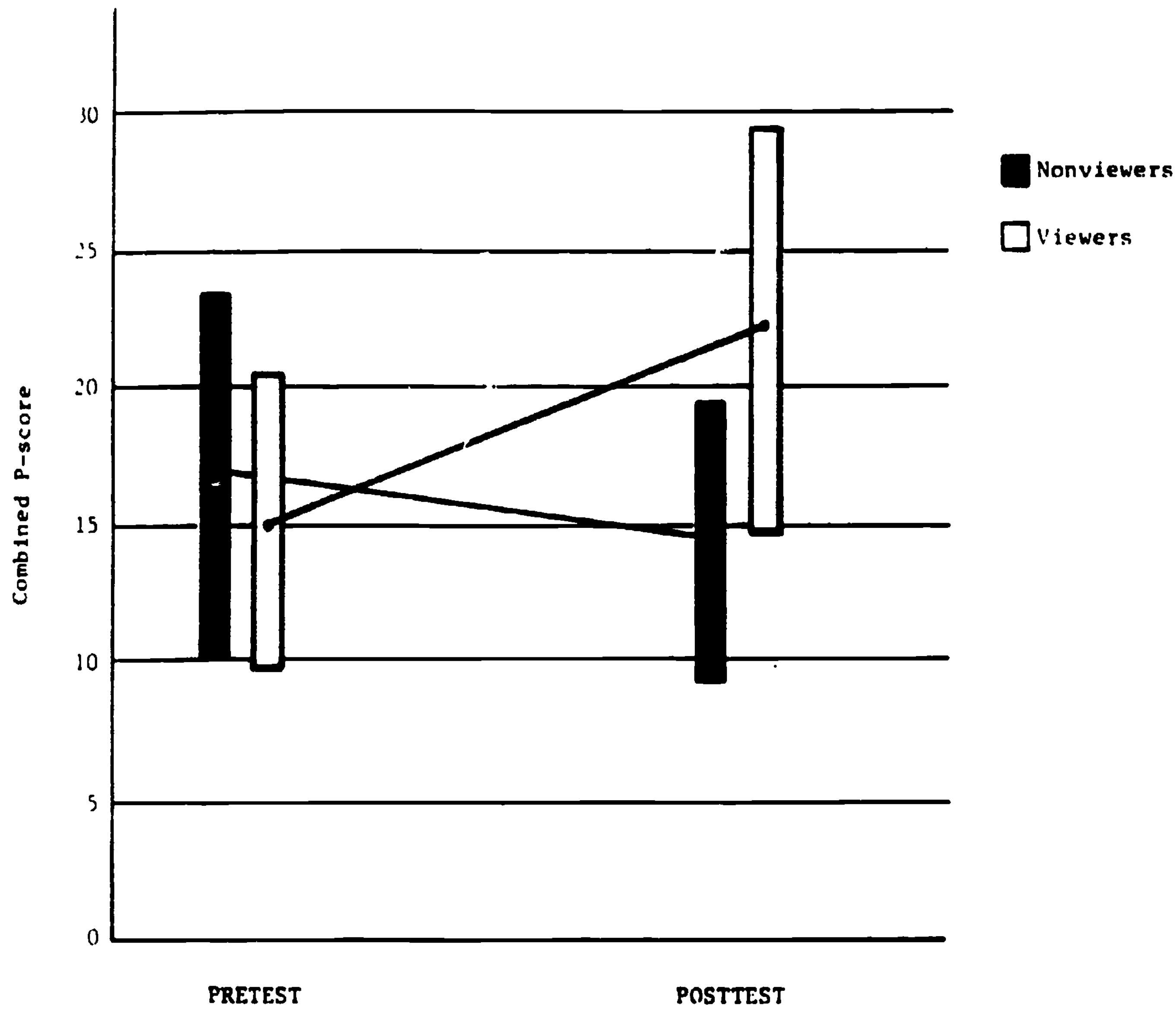

Figure 2. Mean M-scores (all PSAs combined) for Viewers and Nonviewers in Pre- and Posttest with 1 SD above and below the mean.

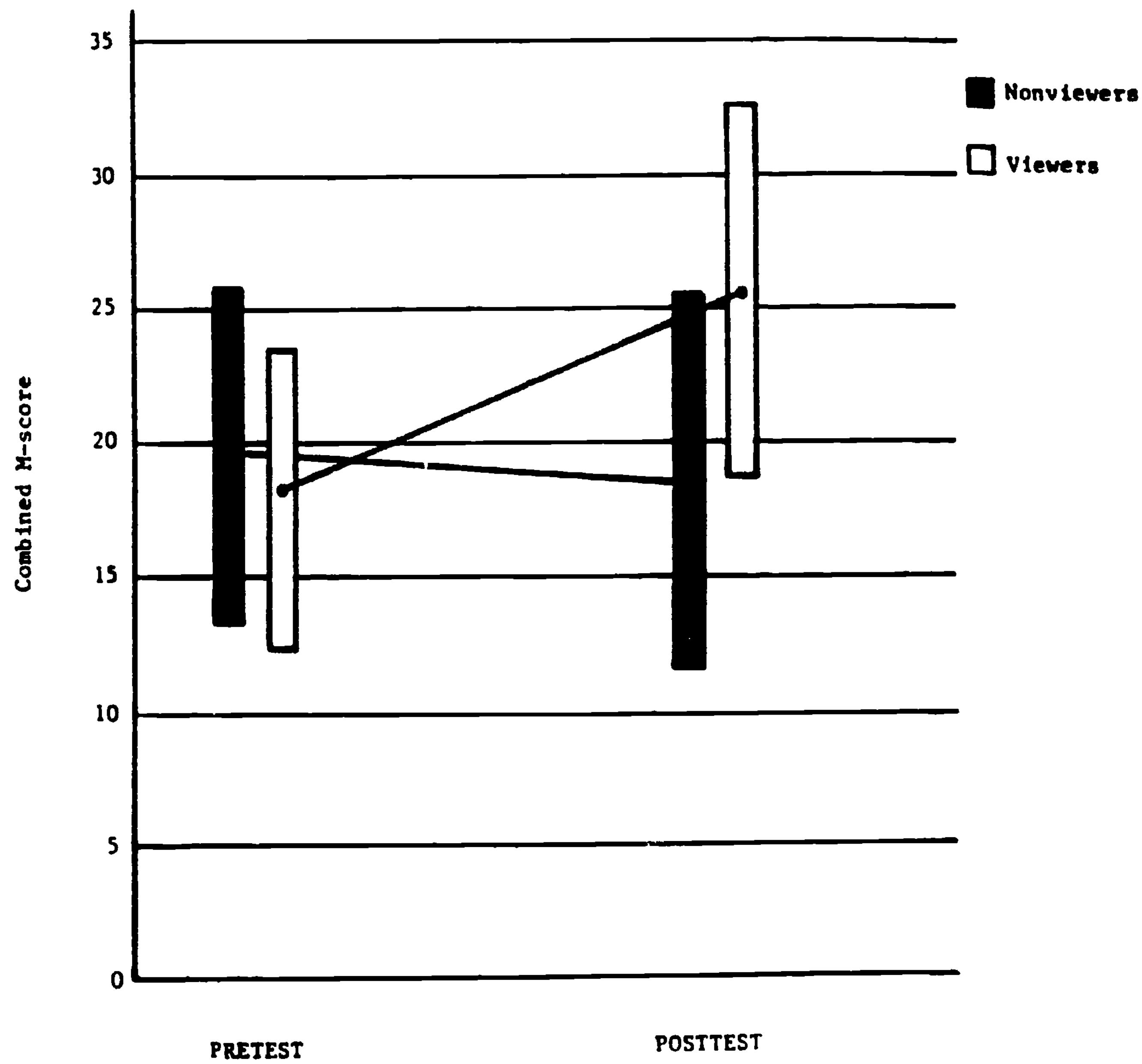

Figure 3. Spinners, number board, and players used in PSA C'