ISSN 0021-8251

JOURNAL FOR RESEARCH IN MATHEMATICS EDUCATION

VOL. 7, NO. 2 MARCH 1976

THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

THE EFFECT OF INSTRUCTIONAL GAMING ON ABSENTEEISM: THE FIRST STEP

LAYMAN E. ALLEN
University of Michigan

DANA B. MAIN
University of Michigan

For Bertrand Russell, the essential features of the good life are affective and cognitive: The good life is one inspired by love and guided by knowledge. We submit that these dimensions are also at the core of good learning, which is a central part of human life. This study focuses on the affective dimension as it is influenced by a learning environment organized around instructional gaming.

Other studies have indicated the influence of such a learning environment on the cognitive dimension. Experimental seventh-grade classes using Equations, the game that is also used in this study, and using the same arrangements with respect to cooperative teams and conduct of tournaments, displayed significantly greater achievement in the learning of mathematics (Edwards et al., 1972). With a different but similar game—Wff 'N Proof: The Game of Modern Logic—and the same other arrangements, groups of junior high and high school students have experienced increases averaging more than 20 points on the nonlanguage parts of standard IQ tests (Allen et al., 1966 and 1970). Still another study reports significant differences on IQ scores for students using Wff 'N Proof (Jeffryes, 1969). However, no significant changes occurred in either the affective or cognitive dimension when the Equations and Tac-Tickle games were used for a shorter period without the tournament procedure, which is designed to individualize the problems presented to each learner and to equalize the reinforcements achieved among all members of the class, and without the cooperative features of the learning environment that are introduced by the teams (Henry, 1973).

The experimental learning environment arranged for this study emphasizes the affective dimension as a facilitator of cognitive achievement. So the initial question to be answered is whether a learning environment organized around games has a positive effect on students' attitudes toward learning. That is the fundamental question to which this study is addressed.

Some evidence exists that a learning environment involving Equations and the appropriate tournament and team arrangements does have positive effects on students' attitudes toward mathematics learning, as measured by students' responses to an opinion questionnaire (Edwards et al., 1972). A more pervasive measure of students' attitudes was sought in the current study—a measure that would reflect student behavior every day throughout the school term. The student absentee rates in experimental and control classes were selected as the measure of students' attitudes toward the learning environment of those classes. In addition to being a more pervasive measure than most indicators of attitudes, it was also a pragmatic one. For any program that seeks to enhance the school's effect on what students learn must first get the students to attend school.

The Learning Environment Organized around Games

The learning environment arranged for this study contained three major elements, each of which was assumed to be critical with respect to the affective and cognitive effects: a problem-generating type of game; a tournament arranged to award reinforcements frequently and equally among the participants as well as to individualize the learning experience for each participant; and the organization of classes into teams designed to elicit cooperation.

The Equations game used in this study is a problem-generating game in exactly the same sense that both checkers and chess are. In each game, when a player makes a choice on his turn to play, he constructs a problem for the other players. When the other player responds, he attempts to cope with the problem that has been posed for him. The choice that he makes in doing so in turn constructs a problem for the next player. That process continues throughout the course of play—successive generation, resolution, and further generation of problems by players. A player who is seeking to win will pose for the other players the most difficult problem that he can imagine under the circumstances. So the level of difficulty of the problem confronting a learner will depend on the imagination and knowledge of the other players in the game. The more a player knows about the game, the more difficult the problems he can pose for others. In Equations, mathematical ideas are incorporated in the rules in such a way that the more a player knows about mathematics, the more difficult will be the problems that he can pose for other players.

This linkage between what a player knows and the level of complexity of the problem that he can generate by his choices in playing has an important implication: it affords a means for individualizing the learning experience for every single student in a heterogeneous classroom. By controlling who plays with whom, one can control the level of complexity of the problem that is delivered to each learner, even though the class consists of students of widely differing abilities and knowledge. It can be assured that each learner is confronted with problems that are of the appropriate level of complexity for him.

The second element of the learning environment under study—namely, the tournament—controls the complexity of problem delivered. If the players in each game are evenly matched in terms of their understanding of the game, they will tend to generate problems of the appropriate level of difficulty for

each other. In striving to win, each will seek to construct the most difficult problem that he can imagine in the situation. When player A constructs the most difficult problem he can for player B—and they are evenly matched—player B will need to struggle and think in order to cope with the problem posed. But—and this is the important part—the probability will be relatively high that B will in fact be able to cope with a problem that he subjectively perceives as a "tough" one. When a player is involved with problems that he thinks are difficult but that he successfully copes with most of the time, he is likely to generate an image of himself as one who can handle difficult problems in whatever subject the game is about—an "I can do it" attitude. By structuring the tournament in such a way that the players are, and continue to be, evenly matched, even though the students may learn at different rates, the attention of each player is focused at the outer edge of what he now understands. That is the objective of the tournament arrangement: to keep the players evenly matched so that the problems delivered to each will be on the frontier of what he currently comprehends. To achieve this objective, the performance of each student is audited at the end of every session.

At the beginning of the tournament the class is ranked according to mathematical ability by the teacher's judgement, by results on a test, by trial play-offs of the game, or by any other reasonable means. It is not especially important that this ranking be accomplished with great exactitude, because the tournament rules provide for subsequent adjustments. The rank list is then used to assign students to the table where each should play. The first three students should be assigned to table 1, the next three to table 2, and so on until all players are assigned. If there is one extra student, the last two tables should have two players; if there are two extra students, only the last table should have two. At the first session of the tournament, every student should play at the table to which he has been assigned. At subsequent sessions a student's table assignment will be determined by his performance in the previous session. For a given session, there will be a high scorer (H) and a low scorer (L) in the game at each table. For the next tournament session the H at table 1 will remain at that table, the H's at all other tables will move to the next lower-numbered tables (the H at table 2 will move to table 1, the H at table 3 will move to table 2, etc.), the L's at all tables except the last one will move to the next higher-numbered table, and the L at the last table will remain there. An absentee player is automatically the L at the table where he would have played. At each table that has three players there will also be a player who scores in the middle (M). The M at each table remains there for the next session. This tournament procedure for moving players about results in a player's shifting to more difficult problems when he has performed well and to less difficult problems when he has not.

This tournament structure and its implications for the affective and cognitive experiences of the learners is probably the most significant aspect of the learning environment of this study. The result of the tournament rules is that in the long run each student in the class turns out to be H about one-third of the time, M one-third of the time, and L one-third of the time. In terms of the game, what amounts to "winning" and "losing" with respect to other players is shared evenly among all. Each turns out to win half the time with respect to others, and to lose half the time. In this manner the competitive aspect of this learning situation is carefully controlled. In terms of wins and losses for purposes of the game, the slow student is not overdeprived and the fast student is not overindulged. Each receives his fair share of each. Reinforcements are evenly shared among all students in the classroom, not unduly heaped on only a few of the brightest.

Furthermore—and this may be the most important affective result of this arrangement—the situation in which each is experiencing such winning and losing leads the players to discover the positive side of losing. To the extent that participants learn that many deprivational situations may be opportunities for growth, they may be learning one of the most important lessons for improving their problem solving in general. The player who loses at table 5 because he did not understand how to subtract negative numbers, but learns how to do so in the process, will have an opportunity to use his new-found knowledge at table 6, probably to good advantage. The player who wins at table 3 and moves to table 2—where he may be walloped by the wizards there—will become aware of the price attached to winning. When these experiences occur repeatedly, players gain a sense that winning is not an unmixed blessing and that losing does not fail to have its compensations. They learn to cope with both outcomes. That is probably a useful capability for situations outside the games.

The third element of the learning environment used in this study introduces further cooperation into the situation by organizing the players into teams. In a major sense, the playing of any game is the essence of cooperation: in order to participate and really play a game everyone must voluntarily agree to abide by the rules that define the game. If someone does not, then he is not playing that game. If one tries to move a knight three spaces diagonally in chess, he is not really playing chess; he is doing something else. But it is a different mode of cooperation that is introduced by the teams in an Equations tournament. They provide a mechanism for further encouraging learning from peers. Game-play facilitates learning from peers of approximately equal ability. Team organization elicits learning from peers of diverse abilities. Whereas the games are played among students of homogeneous abilities, the teams are made up of heterogeneous groups. Each team should have as members one fast learner, one slow learner, and a sprinkling of players in between. The scoring in the tournament is arranged so that a win by a slow-learning member of a team who plays at the high-numbered tables counts every bit as much for the team score as a win by the fastest learner on the team. The fast learner on each team soon learns that if he wants his team to do well in the tournament, he needs to teach the other members of his team some of the things that he knows. Anyone who has ever tried to set up a situation in which bright students teach slower ones knows exactly where the situation usually breaks down—that is, in keeping the bright students interested. But teams bring into the structure of the tournament a continuing motivation for bright students to teach slower students the relevant subject matter. The members of a team do not play against one another except when two of them accidentally move to the same table. Their team activities are cooperative in nature: working problems together, explaining ideas to each other, working through Instructional Math Play kits together, or talking generally about their strategies for playing the games. Hence the mixed cooperative-competitive environment that prevails in an Equations tournament involves competition only when homogeneous groups interact (and even then, under the most careful control) and emphasizes cooperation when the interacting group is heterogeneous.

One final comment is appropriate about the learning environment organized around Equations for purposes of this study. The experimental situation was imbedded in the school curriculum with no disruption of anything that would otherwise be occurring. There was no special selection of the students for the classes, nor did any of them cease their participation in any other usual activity. If reasons arose for adjusting a student's schedule at the end of the fall term and transferring him into or out of the experimental or control classes, that was done; no control was exercised to prevent such changes for purposes of the experiment. In other words, the experiment was adapted to the demands of the school, not vice versa. In this respect, if the results of this experimental program seem to warrant adoption of such a program in other schools, it may easily be fitted into existing school programs. The data collected in this study were obtained not in an antiseptic laboratory environment, but in the ordinary day-to-day setting of Pelham Middle School in inner-city Detroit. We are deeply indebted to three extraordinary educators there for their cooperation and superb efforts in making this study possible: Lewis Jeffries, principal; Gloria Jackson, chairman, mathematics department; and William Beeman, mathematics teacher.

Method

Two kinds of mathematics classes were studied. The experimental group devoted two mathematics sessions a week to an Equations classroom tournament; they heard explanations and worked problems during the other three sessions per week. The control group heard explanations and worked problems individually during all five sessions of the week. The principal difference, then, between the two groups was their activities during two class periods a week.

The absentee rate, computed for each student participating in the study, is the ratio of the number of days absent to the total number of possible school days. Students participated in the study for one or two terms. Approximately eighty school days per term were used in the study.

The study was conducted at Pelham Middle School, Detroit, during the 1972–73 academic year. Every student was enrolled in only one mathematics class, participated in no other mathematics enrichment program, and was enrolled for the full term or terms considered. Students were not tracked according to ability and had no advance knowledge of which sections would be games or which, nongames. One section was an eighth-grade mathematics class; all other sections were seventh-grade mathematics classes. No seventh-grade student had prior knowledge of Equations; the eighth-grade class had participated in the seventh-grade Equations program the previous year.

In the *X* sections, the same teacher taught two games classes and two nongames classes during the first and second terms. In the *Y* classes, the same teacher taught four seventh-grade and one eighth-grade games classes during the first term and four seventh-grade and one eighth-grade nongames classes during the second term. Although it would have been desirable for the experiment to retain all students for both terms, several losses and additions were necessary between the first and second terms because of other scheduling commitments.

Results

Tables 1–3 contain descriptive statistics of the different groups studied. Table 1 presents the descriptive statistics on those students who remained

Table 1
Absentee Rates for Students Enrolled in Games and Nongames Classes of Teacher *X* and Teacher *Y* for the Full Year

	Teacher	Grade	First Term: Games (G)	First Term: Nongames (N)	Second Term: Games (GG)	Second Term: Nongames (NN)
	X	7				
No.			44	14	44	14
Mean			.084	.252	.078	.295
SD			.093	.189	.091	.191
						Nongames (GN)
	Y	7				
No.			57			57
Mean			.076			.130
SD			.106			.140
	Y	8				
No.			23			23
Mean			.057			.131
SD			.071			.088

with the same teacher for two terms. Teacher *X* taught two games and two nongames seventh-grade sections concurrently. Whereas 44 students were enrolled in her games classes for both terms, only 14 students were enrolled in her nongames classes for both terms. Note that the average absentee rates of the 44 games students were .084 the first term and .078 the second term. The standard deviations for both terms are close: .093 the first term and .091 the second. Contrast these to the mean absentee rates of the 14 nongames students: .252 the first term and .295 the second—more than three times as much absenteeism. The differences are graphically summarized in Figure 1. Each term is divided into four quarters for which the absentee rates of games and nongames classes are plotted. The standard deviations for the nongames group are also close to each other: .189 for the first term and .191 for the second.

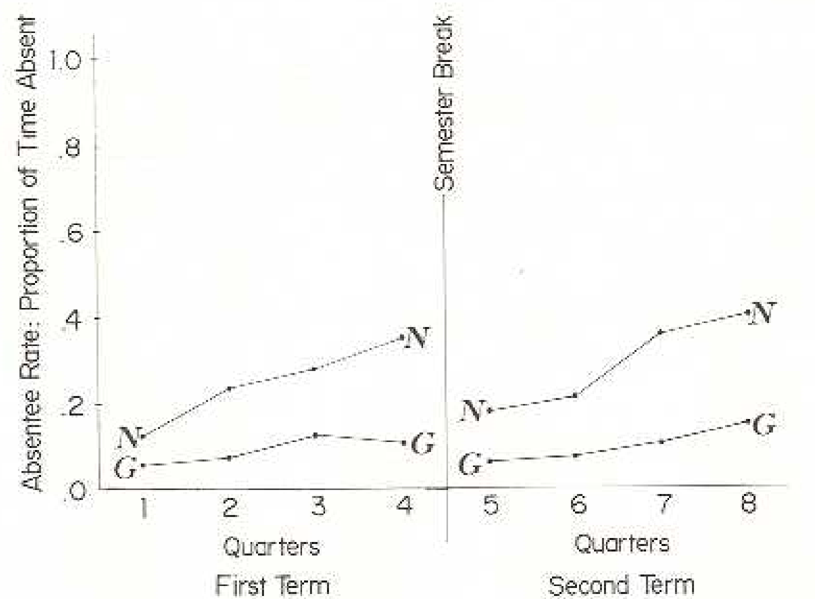

Fig. 1. Absentee Rates of Students in Games (G) and Nongames (N) Classes of Teacher *X* in First Term and Second Term

Teacher *Y* taught four seventh-grade classes and one eighth-grade class each term—all games classes the first term and all nongames classes the second. A total of 57 seventh-grade students were enrolled with *Y* for both terms; 23 eighth-grade students were enrolled both terms. In teacher *Y*'s first-term games classes the seventh-grade mean absentee rate was .076, with a standard deviation of .106. During the second term, when *Y*'s classes were in nongames mode, the mean absentee rate for these same students rose to .130 (nearly double), with an increase in the standard deviation to .140. Eighth-graders in games classes the first term had a mean absentee rate of .057; this rate rose to .131 (more than double) in the nongames second term. The standard deviation increased slightly, to .088.

Table 2 describes data for all students enrolled during the first term in the classes of the two teachers, including those students who transferred out of those classes the second term. Teacher *X* had 57 students in games classes and 42 students in nongames classes. The mean absentee rates are comparable to those in Table 1: the rate is .096 for seventh-grade games students in the first term; it is .246 for seventh-grade nongames students in the first term, with standard deviations of .105 and .234 respectively. Teacher *Y* taught only games sections in the first term, with an enrollment of 88 seventh-graders and 31 eighth-graders. The mean absentee rate for the seventh-graders was .111, with a standard deviation of .166; the rate for the eighth-graders was .086, with a standard deviation of .168.

Table 2
Absentee Rates for Students Enrolled in Games and Nongames Classes of Teacher *X* and Teacher *Y* for the First Term Only

	Teacher	Grade	First Term: Games (G)	First Term: Nongames (N)
	X	7		
No.			57	42
Mean			.096	.246
SD			.105	.234
	Y	7		
No.			88	
Mean			.111	
SD			.166	
	Y	8		
No.			31	
Mean			.086	
SD			.168	

Table 3 presents the mean absentee rates of students enrolled in the second term with teachers *X* and *Y*. Some students had been in games classes, some in nongames classes, during the previous term, and not necessarily with the same teacher. The first column of descriptive statistics is for those students in games sections throughout the first and second terms (GG). The second column describes students in games classes the first term and nongames classes the second term (GN). The third column describes students in nongames classes the first term and games classes the second term (NG). The fourth column describes students in nongames classes throughout the two terms (NN). As in Tables 1 and 2, the data are described by teacher and

grade; the numbers of students, the mean absentee rates, and the standard deviations are given.

Table 3
Second Term Absentee Rates for Students Enrolled in the Games and Nongames Classes of Teacher *X* and Teacher *Y* in the Second Term, Some of Whom Were Enrolled with Other Teachers or in Different Kinds of Classes in the First Term

	Teacher	Grade	Term	Kind of Class			
			First	Games	Games	Nongames	Nongames
			Second	Games (GG)	Nongames (GN)	Games (NG)	Nongames (NN)
	X	7					
No.				46	10	9	36
Mean				.082	.193	.107	.270
SD				.092	.128	.111	.244
	Y	7					
No.					55		25
Mean					.127		.160
SD					.142		.136
	Y	8					
No.					23		10
Mean					.131		.217
SD					.088		.327

Three general hypotheses about absentee rates in games and nongames classes as indicators of differences in student attitudes are of interest and can be tested by the data available in Tables 1–3. The first hypothesis is concerned with testing whether the mean absentee rates of the games classes are less than those of nongames classes taught by the same teacher. This hypothesis can be tested only with the data from the classes of teacher *X*, who was the only teacher to teach both kinds of classes concurrently. The second hypothesis is concerned with testing whether the low absentee rates experienced in games classes in the first term deteriorate significantly when these students are shifted to a nongames class in the second term. A combination of findings—that games classes have lower absentee rates than nongames classes and that these lower rates tend to disappear when students are subsequently switched to nongames classes—would constitute strong evidence for attributing the lower absentee rates to the learning situation organized around games.

The second hypothesis can best be tested with data from the classes of teacher *Y*, who had all games classes in the first term and all nongames classes in the second term, with many of the same students in both. The third hypothesis is concerned with testing whether students who have experienced lower absentee rates through participation in games classes in the first term and are enrolled in nongames classes in the second term (denoted GN) have a lower absentee rate in the second term than students in nongames classes who did not participate in games classes the previous term (denoted NN). In other words, does participation in games in the first term have a carry-over effect that produces lower absenteeism in the second term than there otherwise would be? Data from the second-term classes of both teachers can be related to this question, since each teacher had some GN and NN students whose absentee rates can be compared. These hypotheses are summarized in Figure 2. The first hypothesis can be tested (a) by comparing the

	Teacher	First Term	Second Term
H_1	X	G---N	
H_2	Y	G------------	GN
H_3	X, Y		GN----NN

Fig. 2. Summary of Hypotheses. Null Hypothesis H_1: The absentee rates in games classes are not less than the absentee rates in nongames classes. Null Hypothesis H_2: The absentee rates of students in the first term when they were enrolled in games classes are not less than the absentee rates of those same students in the second term when they were enrolled in nongames classes. Null Hypothesis H_3: The absentee rates of nongames students in the second term who were enrolled in games classes the first term are not less than the absentee rates of other nongames students in the second term who were enrolled in nongames classes in the first term.

absentee rates of students in games and nongames classes of teacher X for both terms (Table 4); (b) by comparing the absentee rates of all students in games classes and nongames classes of teacher X in the first term (Table 5); and (c) by comparing the absentee rates of students in games and nongames classes of teacher X in the second term who had been in the same kind of class the term before but not necessarily with the same teacher (Table 6).

Table 4
Absentee Rates of Seventh-Grade Students Enrolled in Games and Nongames Classes of Teacher X for Two Terms

	First Term		Second Term	
	Games (G)	Nongames (N)	Games (GG)	Nongames (NN)
No.	44	14	44	14
Mean	.084	.252	.078	.295
SD	.093	.189	.091	.191
	Value	Significance Level	Value	Significance Level
F	4.1522	.0002	4.4084	.0001
t	not appropriate		not appropriate	
t^* obs	3.20	<.005	4.11	< .005
t^* .005	2.99		2.99	
t^* .0005	4.17		4.17	
	$P(\text{Mean}_G < \text{Mean}_N \mid \text{Sample}) = .9968$		$P(\text{Mean}_{GG} < \text{Mean}_{NN} \mid \text{Sample}) = .9995$	

Table 5
Absentee Rates of Seventh-Grade Students Enrolled in Games and Nongames Classes of Teacher X in the First Term

First Term	Games (G)	Nongames (N)
No.	57	42
Mean	.096	.246
SD	.105	.234
	Value	Significance Level
F	4.9814	.0000
t	not appropriate	
t^* obs	3.88	< .0005
t^* .0005	3.54	
	$P(\text{Mean}_G < \text{Mean}_N \mid \text{Sample}) = .9998$	

Table 6
Absentee Rates of Seventh-Grade Students Enrolled in Games and Nongames Classes of Teacher X in the Second Term

Second Term	Games (G)	Nongames (N)
No.	46	36
Mean	.082	.270
SD	.092	.244
	Value	Significance Level
F	7.0626	.0000
t	not appropriate	
t^* obs	4.39	< .0005
t^* .0005	3.54	
	$P(\text{Mean}_G < \text{Mean}_N \mid \text{Sample}) = 1.0000$	

In all instances, the null hypothesis is that there is no difference in the absentee rates of students in games and nongames classes. Table 4's statistics describe the students enrolled with teacher X throughout both terms (from Table 1). The F ratio indicates that the variances of the two groups are quite different. A student T statistic, which assumes equal variance, is inappropriate. Therefore, the Behrens-Fisher t^* statistic, which adjusts for differences in the N and the variances, is used. The results indicate that the null hypothesis can be rejected at a significance level of < .005.

The probability that the mean absentee rate for games classes is less than the mean absentee rate for nongames classes is .9968 for the first term and .9995 for the second term. This is a Bayesian posterior probability statement based on a flat prior probability distribution. It takes into account unequal variances and unequal N's and is based on the Behren-Fisher distribution.

An equivalent statement for the first term is $P(\text{Mean}_N < \text{Mean}_G \mid \text{Sample}) = 1 - .9968 = .0032$. As the probability approaches 1.00 (or 0.00, depending on how it is stated), the observer can be more certain that the data indicate that one mean is larger than the other. As the probability approaches .500, the observer becomes less certain that one mean is larger than the other. The Bayesian posterior probability is presented as an alternative way to view the data. It does not test the null hypothesis as the t statistic is designed to do. It simply says that given this sample and no prior knowledge, there is a certain probability that one mean is greater than the other.

Because the number of students enrolled both terms with teacher X in the nongames group was small as compared to the number of students in the games group in Table 4, it was decided that each term should be analyzed separately. Table 5 contains the analysis for the first term; Table 6, for the second term. Note that the F ratio again indicates a big difference in the variances of the games and nongames groups. Since the games group absentee rate is so close to zero, it is understandable that its variance is considerably less than that for the nongames group. The t^* analysis that adjusts for unequal variance and N's is consistent with the former; that is, the null hypothesis can be rejected at a level of significance of $< .0005$ for both terms. The probability that the mean absentee rate for games classes is less than the mean absentee rate for nongames classes is .9998 the first term and 1.0000 the second term.

Turning to the second general hypothesis, the question is: When students are switched to nongames classes following a term with games, does the low absentee rate achieved in the first term deteriorate (increase) in the second term? Tables 7 and 8 present data for students who enrolled for two terms with teacher Y in games classes the first term and in nongames classes the second. Table 7 describes seventh-graders; Table 8, eighth-graders. The

Table 7
Absentee Rates of Seventh-Grade Students Enrolled in the Games and Nongames Classes of Teacher Y for the First and Second Terms

	First Term Games (G)	Second Term Nongames (GN)
No.	57	57
Mean	.076	.130
SD	.106	.140
Mean difference		.054
SD		.076
t		5.3301
Significance level		.0000

Table 8
Absentee Rates of Eighth-Grade Students Enrolled in Games and Nongames Classes of Teacher Y for the First and Second Terms

	First Term Games (G)	Second Term Nongames (GN)
No.	23	23
Mean	.057	.131
SD	.071	.088
Mean difference		.073
SD		.066
t		5.3091
Significance level		.0000

matched t analysis indicates a highly significant difference between absentee rates for the first-term games and the second-term nongames classes.

The null hypothesis—that the absentee rates of students in games classes the first term are not less than their absentee rates in nongames classes in the second term—must be rejected for both seventh- and eighth-graders; the significance level of the t for matched groups in both cases is .0000. The mean absentee rate for seventh-graders in nongames classes is nearly double that in games classes (.076 to .130), and that for eighth-graders is more than double (.057 to .131).

The third, and final, hypothesis deals with the possibility of some carry-over effect from participation in games in the first term to lessen absenteeism in the second term. Absentee rates were compared for two groups of students enrolled in nongames classes in the second term: one group of students had been in games classes in the previous term (GN), one group had been in nongames classes in the previous term (NN). The data are summarized in Tables 9–11. The null hypothesis is that the second-term absentee rate of GN students is not less than that of NN students.

Table 9 summarizes the data for the seventh-grade students of teacher X. The second-term mean absentee rate was .193 for GN students compared to .270 for NN students, a difference of .077. Since the F ratio indicates a difference in the variances at a .0222 level of significance, the Behrens-Fisher t^* value was computed ($t^* = 1.272$). This is not significant at the .05 level ($t^*_{.05} = 1.764$ and $t^*_{.10} = .694$ by the Cochrane-Cox approximation); however, it is significant at $< .10$. The evidence for rejecting the null hypothesis is marginal; it can only be rejected at the .10 level of significance. An alternative way of characterizing the evidence is by a Bayesian posterior probability statement: $P(\text{Mean}_{GN} < \text{Mean}_{NN} \mid \text{Sample}) = .8980$.

The data for teacher Y's seventh- and eighth-grade classes, summarized in Tables 10 and 11, support this marginal finding with respect to the carry-over effect. The difference in mean absentee rates for the seventh-graders is

.033 (.127 to .160) and for the eighth-graders .086 (.131 to .217). These, too, are significant only at the < .10 level. The respective Bayesian posterior probability values are .8330 and .7835.

Table 9
Absentee Rates in the Second Term of Seventh-Grade Students Enrolled in
(1) Nongames Classes of Teacher *X* the Second term and
(2) Games or Nongames the First Term (Not Necessarily with Teacher *X* the First Term)

First Term / Second Term	Absentee Rate in Second Term: Games / Nongames (GN)	Nongames / Nongames (NN)
No.	10	36
Mean	.193	.270
SD	.128	.244
	Value	**Significance Level**
F	3.6584	.0222
t	not appropriate	
t^* obs	1.34	< .10
t^* .05	1.76	
t^* .10	.69	

$P(\text{Mean}_{GN} < \text{Mean}_{NN} \mid \text{Sample}) = .8980$

Table 10
Absentee Rates in the Second Term of Seventh Grade Students Enrolled in
(1) Nongames Classes of Teacher *Y* the Second Term and
(2) Games or Nongames the First Term (Not Necessarily with Teacher *Y* the First Term)

First Term / Second Term	Absentee Rate in Second Term: Games / Nongames (GN)	Nongames / Nongames (NN)
No.	55	25
Mean	.127	.160
SD	.142	.136
	Value	**Significance Level**
F	1.808	.4299
t	.9742	< .10

$P(\text{Mean}_{GN} < \text{Mean}_{NN} \mid \text{Sample}) = .8330$

Table 11
Absentee Rates in the Second Term of Eighth-Grade Students in
(1) Nongames Classes of Teacher *Y* the Second Term and
(2) Games or Nongames the First Term (Not Necessarily with Teacher *Y* the First Term)

First Term / Second Term	Absentee Rate in Second Term: Games / Nongames (GN)	Nongames / Nongames (NN)
No.	23	10
Mean	.131	.217
SD	.088	.327
	Value	**Significance Level**
F	13.800	.0000
t	not appropriate	
t^* obs	.82	< .10
t^* .05	1.82	
t^* .10	.70	

$P(\text{Mean}_{GN} < \text{Mean}_{NN} \mid \text{Sample}) = .7835$

In summary, the results indicate the following:

(1) The probability is .999+, given these samples, that the absentee rate for students in games classes is less than that for students in nongames classes. The null hypothesis—that the absentee rate for students in games classes is not less than that for nongames classes—can safely be rejected. In these samples the mean absentee rate in nongames classes is more than three times that in games classes.

(2) There is a statistically significant rise in the absentee rates of students switched from games classes in the first term to nongames classes in the second term. The rates just about double. The null hypothesis—that there is no increase in absentee rates when students transfer from games to nongames classes—can safely be rejected.

The three-fold difference in absentee rates between games and nongames classes for teacher *X*, combined with this doubling of absenteeism when students are switched out of games classes for another teacher, is strong evidence that this instructional gaming situation markedly decreases absenteeism.

(3) The evidence for carry-over effects, however, is tenuous. Although students from nongames classes in the second term enrolled the previous term in games classes are more likely (about .8) to have a lower absentee rate than other nongames students enrolled the previous term in nongames classes, the data is marginal for rejecting the null hypothesis that there are no carry-over effects to lessen absenteeism in the second term. The null hypothesis can be rejected only at the .10 significance level.

Discussion

That there were profound effects on absenteeism in the Detroit inner-city school where this study was conducted when an Equations instructional tournament was introduced into the regular mathematics curriculum is beyond reasonable doubt. The evidence is clear that absences dropped markedly. Interpreted as an indicator of students' attitudes toward school and what is being done there, such lower absenteeism is perhaps one of the strongest and most pervasive gauges possible of the affective influence of a procedure. To the extent that such gaming techniques jolt this affective dimension, they undoubtedly set the stage for influencing the cognitive dimension. It is hard to improve the way Russell said it in discussing the good life:

> Although both love and knowledge are necessary, love is in a sense more fundamental, since it will lead intelligent people to seek knowledge in order to find out how to benefit those whom they love.

With the games, it is clear, there can be success in creating the love. The next question is obvious: Does it lead to the seeking and achievement of knowledge? In intelligent hands, it should. On this dimension, we need to find out more.

REFERENCES

Allen, L. E., Allen, R. W., & Miller, J. C. Programed games and the learning of problem-solving skills: The WFF 'N Proof example. *The Journal of Educational Research,* September 1966, *60,* No. 1.

Allen, L. E., Allen, R. W., & Ross, J. The virtues of nonsimulation games. *Simulation and Games,* September 1970, *1,* No. 3, 319–326.

Edwards, K. J., & DeVries, D. L. *Learning games and student teams: Their effects on student attitudes and achievement.* Center for Social Organization of Schools, Johns Hopkins University, Report No. 147, December 1972.

Edwards, K. J., DeVries, D. L., & Snyder, J. P. Games and teams: A winning combination. *Simulation and Games, 3,* No. 2, September 1972.

Henry, K. M. The effect of games on cognitive abilities and on attitudes toward mathematics, PhD Dissertation, Oregon State University, 1973.

Jeffryes, J. Let's play Wff 'N Proof. *Mathematics Teacher, 62,* No. 2, February 1969.

Russell, Bertrand. *What I believe.* Allen & Unwin, London, 1925. Reprinted in *Why I am not a Christian.* Simon & Schuster, New York, 1957.