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Computer Gaming: A Strategy for Increasing Students' Sense of Control over their Futures

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Abstract

A series of pilot studies have indicated that a computerized world game can have a significant effect in increasing the players' sense of control over their future. These studies were carried out with students from the fifth grade through graduate school. These optimistic results have led the author to suggest that a complex game, which uses the computer as a computational tool, and where the students compete against "nature" rather than each other, are important elements in game design. Moreover, a game in which reasonable decisions produce satisfying results will tend to increase the sense of future efficacy among its players. Sophisticated System Dynamics models are often excellent game material as well as motivating teaching strategies.

Introduction: Directions from the Literature

The impact of gaming on education has been enormous since computer gaming was first introduced as a classroom tool at an American Management Association meeting in 1957. Over the past twenty years games have been developed to teach or reinforce skills, to give students "practice" in making real life-type decisions, to teach thinking, to help students understand different societal roles. This article reports on studies done to investigate what is potentially one of the most powerful uses of gaming in the classroom: using games to increase students' sense of control over their futures.

Original WORLD3 Equations

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A    FIOAI.K=(1-FIOAA.K-FIOAS.K-FIOAC.K)
A    FIOAS.K=CLIP(FIOAS2.K,FIOAS1.K,TIME.K,PYEAR)
A    FIOAA.K=CLIP(FIOAA2.K,FIOAA1.K,TIME.K,PYEAR)
A    FIOAC.K=CLIP(FIOACV.K,FIOACC.K,TIME.K,IET)
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Sample Replacement to Create Gaming Mode

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A    FIOAI.K=CLIP(X2.K,X1.K,TIME.K,ST1)
A    X1.K=(1-FIOAA.K-FIOAS.K-FICAC.K)
A    X2.K=CLIP(X3.K,I1,TIME.K,ST2)
A    X3.K=CLIP(X4.K,I2,TIME.K,ST3)
                    .
                    .
                    .
A    X11.K=CLIP(X12.K,I10,TIME.K,ST11)

NOTE  SWITCHING TIMES
C    ST1=1970/ST2=1980/ST3=1990 ................./ST11=2070
NOTE  RERUN CONSTANTS FOR INDUSTRIAL INVESTMENT
C    I1=0/I2=0/ ..................../I10=0
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For each rerun of game, change LENGTH to new longer duration, and add C card for the new required I values, A values, C values and S values.

Figure 1. Modification of WORLD3 Model To Create Gaming Mode

The importance of future efficacy as a critical variable in academic performance was first documented by Coleman and Campbell (1966) in their report on educational equality in the U.S. Coleman and Campbell noted that the "pupil attitude factor which appears to have a stronger relationship to achievement than do all the 'school' factors together is the extent to which an individual feels that he has some control over his own destiny" (p. 23).

Several researchers have linked this sense of efficacy with gaming (Boocock, 1968; Burgess & Robinson, 1968; and Carlson, 1971). Boocock expresses her understanding of this link by stating:

> "A final observation about the nature of feelings of efficacy is that they can apparently occur along with a realization of the difficulties of decision making in complex social situations ... "Practicing" in a simulated environment gave some players greater confidence in their ability to control social situations, at the same time they acquired a more realistic view of what the situation was like and saw the necessity for further learning about it (1968, p. 129)."

This article reports on studies using The Limits to Growth WORLD3 model as a classroom game (Meadows et al., 1972; Meadows et al., 1974). The game was designed to be played as part of a world problems study project with students ranging in age from ten years through adulthood. The objective of these studies was to further pursue the notion that game play, as a teaching strategy, positively impacts students' sense of future control. These studies also suggest that any sophisticated computer model, especially one written in DYNAMO (Pugh, 1973), which can be readily converted into gaming format, makes potentially excellent game material likely to provide highly motivating experiences for students of any age.

The World 3 Game

The game used in the five experiences reported here is a modified version of the WORLD3 model. The WORLD3 computer model, written in the DYNAMO language, was altered by the author to allow players to interact with it by making a set of decisions at ten year intervals during the simulation. Figure 1 shows the equation changes made to allow game play. The object of the game is for the players to make a set of decisions that will produce a more liveable world than that projected by the Base Run of WORLD3 (Figure 2). The Base Run simulates population (including birth rate and death rate), natural resources remaining, food per capita, services per capita, industrial output per capita, and pollution level for the years 1900 to 2070. As Figure 2 indicates, this run suggests the world system will collapse between the years 2000 and 2020 if trends continue in the direction they are now going.

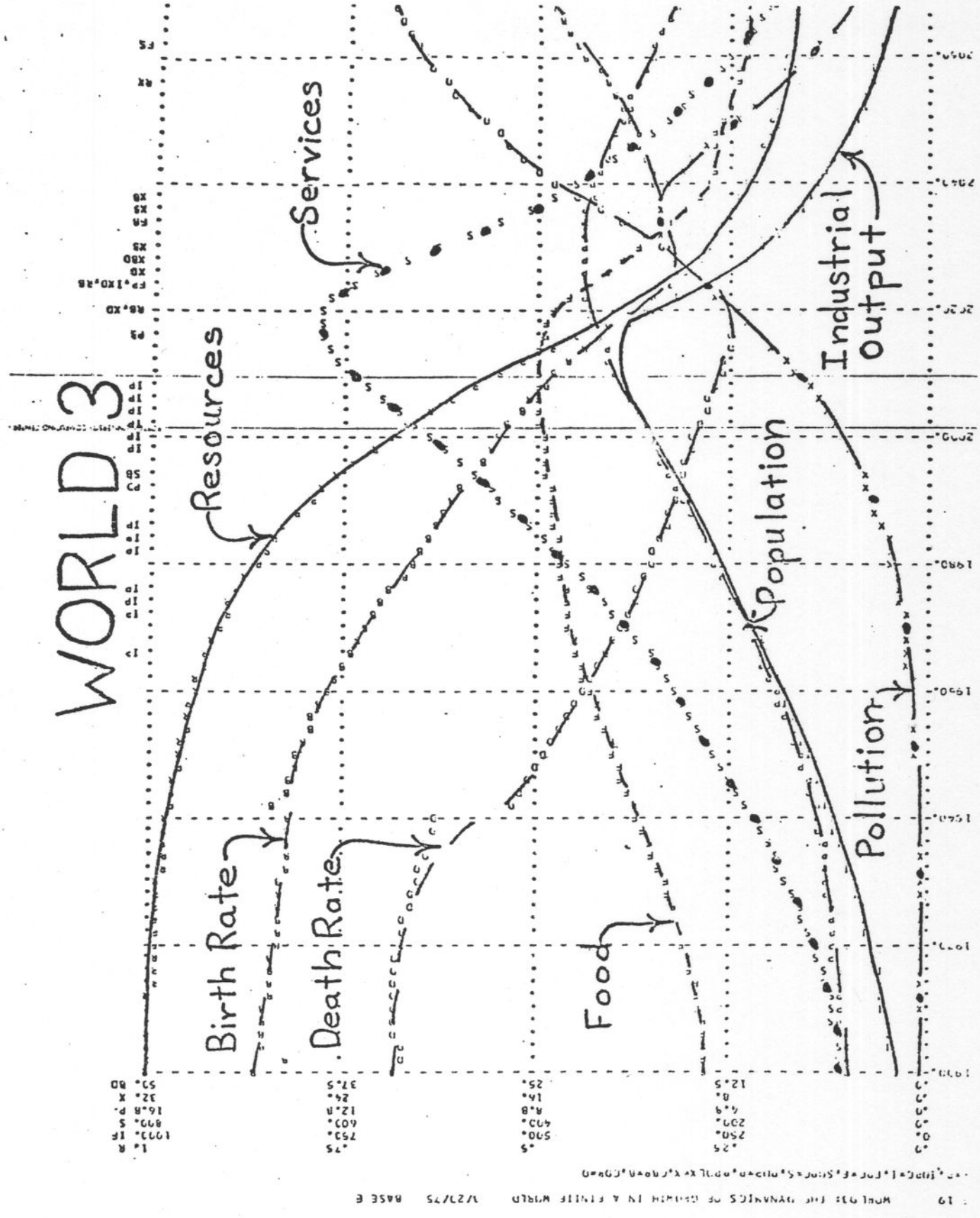

Figure 2. Base Run of WORLD3

Game groups, which consisted of three or four players, were each given a Starting Run (WORLD3 to 1970, Figure 3) which depicts the conditions of the world at present. The groups then decided how they were going to allocate their global resources budget (100%) between the four game areas of the world economy: Agriculture, Consumer Goods, Services and Industrial Output. During the first game session the groups made three sets of decisions, for the decades 1970-80, 1980-90, and 1990-2000 and recorded them on their decision sheets. Each group's decisions were then fed into the computer, using DYNAMO in the rerun mode, and WORLD3 was simulated to the year 2000. A week later the groups were given a computer output, in graphic form, showing the "effect of their decisions on the world". Each group had a different world scenario because its allocations were different.

For the second gaming session decisions were made for the four decades from 2000 to 2040. During the third gaming session, each group of players studied its resulting world to the year 2040 and made its final set of decisions, completing the century of simulation. During the final gaming session each group examined the world it had created, comparing it to the Base Run of WORLD3 (Figure 2). Each group then described its world to the rest of the class, attempting to explain the game results by the set of decisions the group had made. Each group further created a verbal scenario of life in its world, and judged whether it was a more liveable world than that suggested by WORLD3 (Figure 2).

Effect of the game on the participants' sense of control over their future was measured by an Attitude Questionnaire. The twelve questions which measured future efficacy from Coleman & Campbell's study (1966) were randomly divided into a pre and post form. Twelve additional questions were taken from Coopersmith's (1967) Self-Esteem Inventory, rewritten to be of a compatible style, and divided between the two forms.

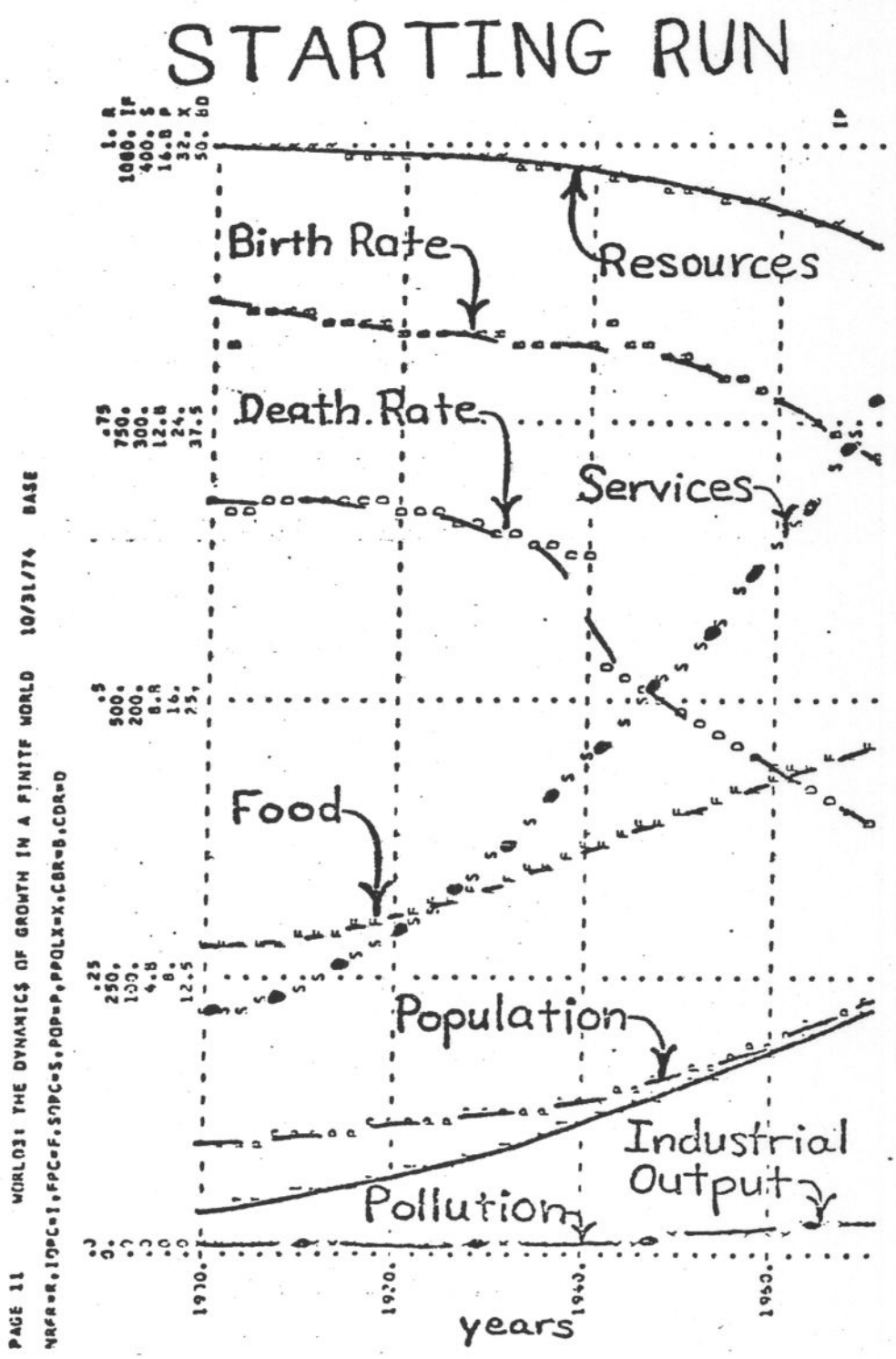

Figure 3. Starting Run for World 3 Game

Study Results

The World 3 Game was first tried to test its playability with two college classes; one graduate, one undergraduate. The Attitude Questionnaire was not administered, but the players were asked: "Did playing the game give you a feeling of having somewhat more control over the world's problems?" Eighty per cent of the respondents answered "yes" to the question.

The second playing of the game was with a suburban sixth grade class (n=14). The game was played for one hour on four consecutive weeks. Both pre and post forms of the Attitude Questionnaire were administered. An increase occurred in sense of future efficacy, significant at the .05 level, for this class of sixth graders (Mann-Whitney U-test).

The game was incorporated in a world problems unit for the next playing. This unit was taught to a fifth and sixth grade class in the same suburban town. The unit spanned a two and one-half month period. The game was introduced after a month of study and followed the same four consecutive weeks format. The pre and post Attitude Questionnaires were administered at the beginning and end of the unit. For both the fifth and sixth grade classes, an increase occurred in the sense of future efficacy, significant at the .01 level (Mann-Whitney U-test).

These classes were also administered pre and post achievement tests covering the material taught in the world problems unit. The achievement test results were correlated with the Attitude Questionnaire in an attempt to identify a relationship between sense of efficacy and achievement (Table 1). Table 1 indicates a clear link between increase in sense of efficacy and achievement for the fifth grade class, but none for the sixth grade.

The most recent play of the game was done with trade high school students. Here the Attitude Questionnaire was administered to a control group as well as the game group. Both groups were studying the issues raised in The Limits to Growth (Meadows, 1972). The control group played no game, while the other group played the World 3 Game for four weeks. The results of changes in sense of future efficacy for these high school students are shown in Table 2. The differences between the pre-Attitude Questionnaire

Table 1

Correlation Between Sense of Efficacy & Achievement

Unit Plus Game Study

Grade	Correlation* Pre-Achievement vs. Pre-Attitude	Correlation* Post Achievement vs. Post-Attitude	p
5 (n=22)	-0.03	0.36	.05
6 (n=26)	0.25	0.27	.10 .10

* Spearman rank correlation coefficient

Table 2

Changes in Sense of Future Efficacy

Trade High School Students

Group	Mean Attitude Scores Pre	Post	U*
Control (n=13)	22.15	18.50	40
Game (n=12)	21.67	24.08	68

* Mann-Whitney U-test, results not significant

Table 3

Comparison of Pre & Post Attitude Scores

Control vs. Game Group, Trade High School

Form	U*	P
Pre	76.5	---
Post	26.0	.025

* Mann-Whitney U-test

scores and the post-Attitude scores for the two groups were also investigated. Table 2 indicates no significant increase in sense of efficacy for either the control or the game group. The control group's sense of efficacy decreased in the four weeks between questionnaires. However, when the post scores of the two groups are compared (Table 3) the game group shows a significantly higher sense of efficacy at the end of the four weeks. Moreover, the game group's sense of efficacy appeared to increase slightly, while the control group's sense decreased (Table 2).

Discussion

The studies conducted with the World 3 Game suggest it is an effective tool for increasing students' sense of control over their futures. Moreover, one of the studies (fifth grade class, Table 1) gives some indication that this can be correlated with academic learning. Several reasons might be put forth for the effectiveness of the World 3 Game.

First, the WORLD3 System Dynamics computer model was developed by a team of researchers at M.I.T. during a several years effort. The WORLD3 model represents the world in as complex a fashion as then seemed possible and desireable. The gaming version of the model did not necessitate simplifying the model at all. Thus, the world the students manipulate is quite complex. The computer is used to carry out the infinite number of computations required for each round of play. The students, during the course of game play, are able to develop mastery of these tools, and indirectly, of the world they manipulate.

Secondly, the game teams are not competing against each other, but rather against the Base Run of WORLD3 (Figure 2). As Clayton and Rosenbloom suggest:

> "We believe that the fruitful path is to choose games which emphasize strategy and structure, rather than personal roles. Moreover, if children play against "nature" rather than against other children, feedback can be specifiable and immediate (that is, children compete against each other, but direct interaction is with"nature") (1968).

Finally, after many plays of the game, the author realized that almost any set of reasonable decisions produced a more liveable world than that shown in Figure 2. It appears that each group how played the game could easily come away with the feeling that if they made world decisions over the next several decades, the world would be in better shape than what was projected by the base scenario of the WORLD3 model.

These experiences with the World 3 Game suggest an exciting use for the many complex computer models developed initially for research and/or real world problem-solving. By bringing these computer models directly into classrooms in the form of games, students will be exposed to the forefront of research in many disciplines with almost no delay time. Complex models can be brought into even the most elementary courses in the form of computer games, enabling students to investigate very current research from the beginnings of their studies. As indicated by Figure 1 the modifications needed to convert all System Dynamics models into this gaming format are easily accommplished.

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