COMPUTER ADVENTURE GAMES AND THE DEVELOPMENT OF INFORMATION PROCESSING SKILLS

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Information Processing Skills

Among the many recommendations of the National Commission on Excellence in Education is included: "Instruction in effective study and work skills, which are essential if school and independent time is going to be used efficiently, should be introduced in the early grades and continued throughout the student's schooling (1983:29)." This proposal is not particularly novel, yet most surveys show that the average teacher pays very little attention to instruction in study skills (e.g. Askov, Kamm & Klumb, 1977; Askov, Kamm, Klumb, and Burnette, 1980).

While study skills do not receive much attention in the classroom, they have generated a great deal of interest in the university research community, under such labels as megacognition, mnemonics, planning, monitoring, learning strategies and tactics. (See Forrest-Pressley & Gillies, 1983, for a review.) We will use the all-encompassing term *information processing skills* to describe the collection of skills which the student may use during the course of processing a circumscribed body of educational material. The research literature suggests a number of tentative conclusions about the student's use or non-use of information-processing skills.

Cook and Mayer (1983) reviewed research which shows that when information processing skills are employed, success at learning, problem-solving, and remembering is enhanced; that is, such skills *do* make a difference. However, they and Hale (1983) point out that these skills are not learned spontaneously by most students, and when known are not always put to use when the situation would seem to call for it. They conclude that one needs to *teach* information processing skills *and* when to use them.

Other investigators have provided specifics on this general topic. Barclay (1979), for example, suggests that students do not use information processing skills because they fail to see their efficacy. This point was confirmed in a study by Paris, Newman and McVey (1982) in which students who were given elaborate feedback on the effects of their own information processing skills used these skills much more effectively. Similarly, Anderson (1980) reports that information processing skills are used more effectively when students are provided with adjunct study aids to guide and reinforce their application. Finally, however, we take note of Peterson and Swing's (1983) cautionery review which underscores the need to test these laboratory findings under real world conditions.

The Promise of the Computer

The same commission reports which pointed to the need for increased emphasis on study skills also recommend the rapid expansion of computer-assisted instruction. Again, however, a comprehensive survey has shown that while the number of computers in the schools has increased exponentially, their use has remained low. Becker (1983) found that up to a quarter of all elementary schools surveyed use their computers no more than an hour per day. Undoubtedly, one of the main reasons for this state of affairs is the lack of good educational software. For example, while hundreds of pieces of software have been evaluated by the Educational Products Information Exchange Institute (EPIE) only 3 to 4 out of a hundred are judged "excellent" and only about 25 out of a hundred meet what EPIE considers to be minimal standards (Komoski, 1984).

There are, however, many exemplary programs for children on the market, although they don't happen to be labeled "educational." "Fantasy adventures," "adventure games," "mystery adventures," and "role-playing games" are of particular interest (Stanton, Piochowansky & Meilin, 1984). A blue-ribbon report to the National Science Board, has recommended the use of "education games, including adventure games, which develop reading comprehension and problem-solving skills" (Coleman & Selby, 1983:53). In a similar vein, Cook (1983; see also Unwin, 1983) lists a vertible catalog of skills which are exercised in the course of playing an adventure game including map-making, record-keeping, reading, problem solving, and note-taking. Several of the items on Cook's list are information-processing skills. However, there is a lack of research investigating the instruction effects of adventure games. The issue we would like to address, then, is whether, via the medium of adventure games, an underutilized resource, the computer can be employed for instruction in a neglected area, information processing skills.

An Adventure Games Curriculum

The basic format of the adventure game is the "quest." The player is presented with a series of dilemmas he/she must resolve in order to complete the quest; e.g., finding the treasure, rescuing the maiden, identifying the criminal. Although the adventure game has been around for a long while, there have been four recent noteworthy developments in the genre. First, personal computers with extensive memory capabilities have led to the addition of snappy, colorful graphics to support the prose portion of the adventure. For example, "Death in the Caribbean," released late in 1983, has many "screens" or illustrations, each a masterpiece of the computer illustrator's art. Second, adventure games have become much more complex. Early adventure games offered students a very limited response repertoire: "right," "left," "stop." Newer fantasy adventures accept hundreds of English words or phrases as legitimate commands. The adventurer can walk, run, climb, open things, interrogate, and turn on lights as he/she collects clues and equipment needed to succeed in the adventure (Strehlo, 1984). Third, the depiction of the fantasy has become much richer. In addition to the added graphics mentioned above, many adventure games now come with novels, posters, treasure maps, and other "props," all designed to elaborate and deepen the player's involvement with the fantasy. Fourth, adventure games have broken out of a narrow mold (explore "rooms" in a house or cave) and begun to take on the great variability characteristic of juvenile fiction. "Sci'fi" titles are well represented, as are detective mysteries and dungeons and dragons. Increasingly, however, we will see fantasy adventures patterned on specific childrens' classics like "Jenny of the Prairie" from Rhiannon Productions. In addition to the topical variety, Sierra-on-Line, a leading video game company, has broken new ground with "Troll's Tale" and "Dragon's Keep," two fantasy adventures prepared with younger children in mind. The text portion of both of these adventure games has been carefully written at the third grade reading level.

All of these characteristics have a bearing on the enormous appeal of adventure games and lead us to think that they might be used in an area where the present array of instructional offerings is limited and uninspiring. Beyond their motivating power, adventure games have at least two features which the research literature suggests are important in the development of information processing skills. First, it is immediately apparent to the player that he/she will have to have some means of keeping track of all the information. Adventure games inevitably incorporate numerous characters, scenes, tools, treasures, locations, written messages as well as possible other information. Second, the game provides immediate feedback, in the form of forward progress through the adventure if the right decisions are made, or, death to the player, for wrong decisions. Thus, the player will be given a clear indication of the adequacy of his/her information processing techniques.

On the other hand, we were not so naive as to think that merely giving students access to adventure games would result in the acquisition, use and transfer of information processing skills. We previewed and allowed children to play nearly 30 adventure games and eliminated from further consideration those that seemed too difficult for elementary-middle school age children or that did not hold the students' interest and attention. Because adventure games vary enormously in difficulty, we prepared a "developmental sequence" that would introduce the student gradually to the genre and move towards games in which more and more information had to be processed with fewer and fewer aids provided by the computer itself. This sequence ultimately consisted of "Dragon's Keep," "Troll's Tale," "Mystery at Pinecrest Manor," "Death in the Carribean," and "Dark Crystal," in that order.

Each game either came with its own "adjunct study aid" or we constructed one for it. In the case of "Dark Crystal," for example, we gave the students oversize graph paper and showed them how to "map" their movements. Students would be encouraged to use these aids, but not required to do so because we hoped they would themselves come to appreciate the aids' usefulness.

Although our central question should now be clear, we are not prepared to provide an unequivocal answer in this first, small-scale study. The study should be viewed as a pilot. Among the feasibility issues we wanted to explore were: How do students respond to a cognitively challenging and complex game? Will they persevere in their effort to complete the game? Are students with prior computer experience more proficient at playing adventure games? Is it possible to assist students in solving the difficult parts of the adventure by providing hints? Do students cooperate or compete with each other as they attempt to discover solutions to dilemmas posed in the adventure? Is there a discernible interaction between particular games and particular students, e.g. are there obvious preferences? Are these preferences a function of gener? Can a project of this nature be implemented in a computer lab with 25 + students? Do students get better at solving adventure games with practice? Some of these questions were answered with more assurance than others.

Procedures

The purpose of this pilot study was to examine the feasibility of using computer adventure games to teach study skills. We used a pretest-posttest control group design (Campbell and Stanley, 1966), augmented by extensive observation during the treatment period.

To obtain subjects we advertised an experimental program in the Microcomputer Learning Center to be held in conjunction with the campus lab school's summer program. The program ran from 12:30-2:30, Monday-Thursday for four weeks and the fee assessed was $15.00. The program was limited to students in the 4th-8th grades. Not surprisingly (e.g. Miura & Hess, 1983), of the twenty-two students who signed up, 16 were male. We randomly assigned the students to experimental and control groups. The eleven students (7M, 4F) in the experimental group had a mean age of 12.1 (SD = 1.0) and grade of 6.0 (SD = .9), while in the control (9M, 2F) the mean age was 11.6 (SD = 1.1) and grade was 5.3 (SD = .6).

A widely used measure of information-processing skills is the study skill element of the Wisconsin Test for Reading Skill Development (Stewart, Kamm, Allen, & Miles, 1973). Among the various sub-tests available, we determined that note taking and outlining best reflected the kinds of skills likely to be exercised in the course of playing adventure games. Specifically, we pretested with: Level E, Skill 14 Note taking; Level F, Skill 11 Outlining; and Level G, Skill 10 Outlining. Posttests were administered using different forms of the above.

There were 11 computer stations in the lab (9 Apple IIe's and 2 Commodore 64's), each with CPU, color monitor, disc drive and game controllers. Students were assigned in pairs to specific stations at the beginning of each session. At each station, we booted up the particular game that we wanted that pair to play. In the experimental group, students were assigned to "Dragon's Keep" until they finished it, then "Troll's Tale," then "Pinecrest Manor," progressing to the more difficult games. Records were kept of how long it took each pair to complete each game.

For the control group, we booted up various video games from our library. At the end of an hour, students were free to exchange the game they were playing for any other game from the library. Most took advantage of this option except some of the older students. When heavily involved with "Death in the Caribbean" or "Dark Crystal," they would spend the entire session with one of these games. After the first week, we also found it necessary to let students choose new partners within their respective groups. The main outcomes of student's selection of their own partners were to eliminate mixed-sex pairs and to better match the skill levels within each pair.

Students in the experimental group were given adjunct aids to assist their processing of information during play. For the first two games, we used aids provided by the game publisher. Each came with a quasi-map which guided the students travel through the territory and also provided a mnemonic for keeping track of treasures collected or animals released from the "Dragon's Keep." For "Pinecrest Manor" and subsequent games, we gave the students a simple aid which we had devised. A sheet of paper was ruled off into three sections labeled "commands," "item chosen," and "information or result." When we presented this to students, we explained it was for recording and making notes of important information they gained from playing the game and reminded them regularly during play to use it. "Death in the Caribbean" came with its own map. We had it laminated and gave the students erasable marker pens and showed them how to take notes on the map itself. For "Dark Crystal" we gave the students oversized graph paper and showed them how to make a schematic as they proceeded to explore the territory. We gave no general instruction in note-taking, outlining or map-making.

As game play proceeded, the proctors moved around the room recording observations and assisting the students. There were never fewer than two proctors available at any time and there were usually three or four. All were experienced computer users and adventure gamers. We acted often to help students get around particularly difficult obstacles in order to keep their frustration at tolerable levels. We also offered encouragement to use the information processing aids.

Test Results

We administered study skill tests to all the students who had registered to take part in the computer workshop. However, attendance was eratic so we will report the results for those students on which we have complete data. Pretests and posttests in outlining and note taking were used in the study. Table 1 indicates the results of the outlining tests.

Several problems are immediately apparent from Table 1 aside from the 36% attrition. First, there is a ceiling effect whereby many students get perfect or nearly perfect scores on the pretests. Second, the within group variance is extremely high. Third, many student's scores actually decline from the pre to posttest. In view of these severe technical problems, we have made no further attempt to analyze these data.

Table 1
Percentage of Correct Responses on Outlining Pre and Posttest

Student	Level F Skill 11 (Outlining)		Level G Skill 10 (Outlining)	
Experimental Group				
	Pre	**Post**	**Pre**	**Post**
Alice	92	67	20	13
Joan	92	92	73	87
Steve	92	83	7	73
Joyce	83	50	13	27
Tyler	83	83	20	27
Mike	67	83	60	33
Kevin	92	75	100	67
Control Group				
Jane	83	92	73	67
Brady	33	100	93	87
Chris	75	9	80	100
Matthew	83	92	13	80
John	100	100	92	100
Kyle	67	83	60	33
Bryan	75	58	67	53

*Names of Students have been changed.

In addition to outlining, we also examined the notetaking skills of the students. We used *Skill 14, Level E Notetaking* as a pretest measure. We used this pretest performance as an indicator of the general level of proficiency students had in the skill. However, since no posttest of this skill is provided by the test developer, we had to resort to subjective judgment concerning student achievement in this skill. In an effort to assess any gains in notetaking proficiency, we examined the student's record forms and maps from their individual files. Based on the completeness or incompleteness of the records that students turned in each day over the course of the program, there was no noticeable change in the extent or quality of notetaking. However, as we will point out in the following sections reporting our qualitative findings, the students simply did not make extensive use of notetaking, outlining or map-making as they played the games, so it is unreasonable to expect them to have improved much in these skill areas.

Observations Regarding Students

Initial interest varied greatly, however, all students eventually got deeply involved with their respective games. The shift from low to high interest was particularly noteworthy for girls. Although we scheduled a break after the first hour, most students refused to stop playing the games and elected not to take a break. Attendance varied a great deal. Several students came to every session and some students were invariabley 15-30 minutes early. On the other hand, family vacations and other summer activities had a marked effect on attendance and some students attend 1/3 or fewer sessions. However, attendance patterns did not vary noticeably between experimental and control groups.

An aura of cooperation and collaboration permeated the learning center. The most popular game among the more than forty we made available to the students was "Peanut Butter Panic" which requires that two players cooperate to make peanut butter sandwiches and score points. Regardless of the game, players tended to cooperate with each other. However, mixed-sex pairs did not cooperate and were eliminated when we let them freely choose their partners, a move which resulted in higher levels of cooperation for nearly all pairs. As students in the experimental group had to deal with more and more challenging adventure games, the level of cooperation increased as each pair shared its discoveries with other pairs.

We also note that, despite the fact that students were engaged in "play" throughout the session, discipline problems were nonexistent. By utilizing a large library of games and giving students freedom to choose which games to play, we kept them squarely "on-task." A disadvantage of having game variety and flexibility, however, was that the adventure games tended to be less attractive by comparison to many of the more exciting and less (intellectually) demanding video games.

Observations Regarding Games

Perhaps the most remarkable thing about computer games is that students assume they can readily figure out how to play them. They do not sit around waiting for someone to show them what to do and in many cases, they are right. The best games (e.g. "Peanut Butter Panic") have brief instructional sequences at the beginning and gradually increase in difficulty as the players become more proficient.

In the general area of adventure games, many problems emerged which will need to be solved before their full educational potential can be realized. Even the simplest games like "Dragon's Keep" and "Troll's Tale" presented some insurmountable obstacles to some students, fortunately, other students who had already mastered the game were only too willing to help. On the positive side, the "adjunct aids" that come with these two games were very effective and students made good use of them. With the more difficult games, problems with vocabulary and syntax were encountered, students had to learn fairly arbitrary conventions about what the computer would or would not accept by way of commands. Another problematic area was the lack of predictability in some of the games whereby a strategy which worked once wouldn't work the second time through. This randomness is a feature of most board games, of course, as when the dice is tossed, but it plays havoc with attempts to teach students to keep systematic records of their actions.

Adventure games strain the standard definition of games in other ways. For example, students are accustomed to playing a game and winning, at least some of the time. However, none of the students succeeded in solving "Death in the Caribbean" or "Dark Crystal" despite an aggregate over the group of at least 50 player hours invested. Most board games last less than an hour, whereas, computer adventure games can take days to complete. They are, in this sense, similar to "Dungeons and Dragons," which our subjects had not played to any extent.

These definitional issues are in no sense trivial. We know from previous research (e.g. Lancy, 1975, a,b) that students freely define various school activities as "work" or "play" and their behavior is guided accordingly. With "Pinecrest Manor," "Death in the Caribbean" and "Dark Crystal," students did *not* make extensive use of the adjunct aids to guide their application of information processing skills. Nor (in the case of "Dark Crystal") did they take full advantage of the documentation provided by the company. In all these cases, there was an implicit message of "this stuff is work—it gets in the way of our playing the game." For example, the map in "Death in the Caribbean" was used much more extensively than the map in "Dark Crystal," because (a) it was provided as part of the game rather than having to be drawn by the student, and (b) it was very colorful and "authentic" looking. Another possible reason, of course, for the failure to utilize explicit information processing strategies was that, as research suggests, is students have had so little experience in doing so. Finally, we would note that there seemed to be a trend whereby older players made much greater use of the study aids than younger players.

Discussion

It should be re-emphasized at this point that this study was not designed to establish conclusive or generalizable hypotheses concerning computer adventure games. In this pilot study we wished to explore some informal hypotheses, but also wanted to observe students' interaction with computer adventure games as a learning environment. We also wanted to generate potential hypotheses for future research. In the remainder of the paper, we will discuss some implications of our study and offer some suggestions for possible areas of future research. In addition, we will provide some ideas regarding the usefulness of adventure games in a school setting.

Due to the rather challenging and difficult nature of the available software, we would suggest that fifth grade students or above be used in studies utilizing adventure games. We would also suggest not having control gorup and experimental group students together at the same time. As experimental group students observed control gorup students playing different "video games," they would sometimes become more interested in these games than in the ones they were assigned to play. This "conflict of interest" appears to be unavoidable to a certain extent, given the "shoot and kill," "run and jump," constant action format of the "video game" opposed to the thoughtful, methodical, "problem solving" skills required for interaction with the adventure game.

Another implication for future research concerns the use of existing test measures. Based on the inconclusive test results from the measures that were used to assess the development of study skills in this project, we would suggest that researchers consider the development of their own measures. We are unaware of available tests that would better assess the information processing skills that were of interest to this study.

It should also be noted that even though the students were assumed to have received classroom instruction in the use of study skills, it became apparent that structured intervention would be needed if these skills were to be fully utilized by students. There is a need to help students become consciously aware of the value and use of the techniques of information processing needed for successful interaction with computer adventure games. While we provided adjunct aids for the students' use in notetaking and outlining, these aids need to be "integrated" more fully with the games. In other words, based on the actions of the students, it seemed they could easily recognize the value of a map that came with a game, but failed to see the value of "mapping" their movements in games that did not provide a map.

Finally, we would recommend that future studies be conducted during regular school sessions rather than in summer computer workshops or after school computer clubs. This would help avoid the problems with student attendance. In our study, even though students paid a small tuition to participate, they were forced to miss sessions due to family vacations or outings. Summer school computer activities must compete with many other very attractive activities. We would recommend that approximately 30 minute daily sessions in a classroom or school computer lab be the setting for research investigating the value of computer games. Student selection or participation in a study could be based on enrollment as a reward activity or an enrichment activity.

Suggestions for Further Study

Computer adventure games present three kinds of opportunities for further study. First, adventure games may provide opportunities for the development of certain relevant cognitive skills while helping to overcome any apprehension that students might have about computers. Second, as a cognitively demanding task in their own right, adventure games require creative and problem-solving responses from students that are worthy topics themselves. Third, adventure games may provide an environment in which differences in style or developmental stages, particularly those that relate to problem-solving, may be examined.

Given the small sample of our study, we were left with more questions than answers. Some that warrant consideration for future research are:

1. How are the activities of exploration and experimentation, and the type of questions asked by students, related to success in adventure games? What are the different problem-solving strategies employed by boys and girls, and are these related to success at adventure games? Do these differences (if any) relate to learning differences in other related areas of study: computer program, mathematics, science?

2. Is there relationship of performance of success with adventure games to learning computer programming? Does practice with adventure games improve the ability to understand programming principle?

3. Are there certain cognitive skills that can be enhanced by participation in adventure games?

4. Is there a relationship of performance on computer adventure games to analyzing verbal logic problems incorporating the same concepts? Does practice with adventure games enhance the ability to solve such problems (or vice versa)?

Classroom Use of Adventure

To get the most good from student participation with adventure games, it appears to require three steps: (1) getting the student to actually work with the programs, (2) making them aware of the processes they are exploring, and (3) extend their learning to related areas. Each of these areas can be supported by a variety of activities. Dickson and Raymond (1984) suggest that the following are representative of possible activities a classroom teacher might consider.

1. Motivations: Getting students merely to play the adventure is not ordinarily the concern; the concern is to get them to play the game you want them to and staying with it long enough to achieve your instructional purpose. To encourage students in a certain direction, at least two suggestions are worth consideration:

(a) Sponsor an adventure club, which could meet after school or during an activities period.
(b) Sponsor a competition, rewarding the students who solve the adventure most quickly, most efficiently, or with the most treasure or loot (depending on the format of the adventure game).

2. Sharpening Awareness: We are hearing and reading more often that to improve students' writing they should read more and that writing will help students better understand what they read. However, we know that this is not an automatic process. Students need to be made self-consciously aware of techniques employed by authors of the works they are reading. The same is true of adventure games. To gain the most from these games, students must be made to think consciously about the techniques they are observing and recording.

(a) Ask student to describe the characters and summarize the plot of the adventure with which they are working. This will most likely require making or using a map or notes on which the character's journeys and encounters have been recorded. (The charting and recording of such information are useful skills in themselves.)
(b) Ask students to describe, not merely the plot, but the logical puzzles they have encountered and solved. The actual solution might have come through common sense, intuition, clever deduction or just plain luck. However, once they have a solution they can be encouraged to work backward and decipher the logical processes involved in its solution.

3. Extending the Learning:

(a) Ask students to write either of the above activities in essay form. This combines metacognitive awareness with writing practice.
(b) Students can illustrate key episodes of the adventure.
(c) Ask students to develop and write their own adventures. These can be mock adventures in which they establish a scenario, set up puzzles, map the setting and provide the command sequence. It is now possible with programs such as "Adventure Master" from CBS software, for students to develop and program their own adventure with very little computer or programming experience.

The above respresents but a few of the potentially beneficial uses of adventure games in the classroom.

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