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ABSTRACT

The effects of group computer-based instruction and learning style on achievement and attitude were studied for 190 elementary school students in grades 4 and 5 in Austin (Texas). The cooperative learning methodology chosen for this study was "Learning Together." Learning Together is a cooperative learning method emphasizing five major elements: positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing. This method was chosen based on its ability to be easily adapted to existing curriculum materials. Instructional materials included a computer-based tutorial on astronomy. Performance was measured using a multiple-choice paper-and-pencil test, and questionnaires assessed student attitudes. Students were assigned to six experimental conditions of cooperative or individual learning stratified by learning style. Results do not support the hypothesis of interaction between instructional delivery and learning style for both performance and attitude. Recommendations for further research are made, and some suggestions for applications of computer-based instruction are offered. (Contains 71 references.) (SLD)

Title:

The Effects of Group Computer-Based Instruction and Learning Style on Achievement and Attitude

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The Effects of Group Computer-Based Instruction and Learning Style on Achievement and Attitude

Over the past twenty years, computers have been introduced and used in the classroom in an effort to facilitate the learning process. Matta and Kern (1989) stated that the computer has become an increasingly popular technique [tool] in education. In fact the literature we find a plethora of studies which compare computer-based instruction (CBI) to traditional instruction yielding relatively positive results. Although much has been learned in the comparative research of CBI to traditional instruction, scholars in the past few years have become critical over continuation of comparison research (Clark, 1983; Dalton & Hannafin, 1988). Instead of comparative research, we find scholars who advocate the investigation of instructional design and human factors be considered (Clark, 1985; Bracey, 1988; Robyler, 1985). Jonassen (1988) argues that learning is affected more by instructional design factors than the various types of media (including computers). Studying factors, such as cooperative group learning and learning styles in conjunction with computer-based learning environments, may yield valuable information for instructional designers who develop materials using a variety of delivery systems in a variety of settings for a variety of learners.

Furthermore, instructional design scholars and practitioners often advocate that recognition of individual differences is important. Recognition of the fact that individuals learn differently is critical for designing effective instruction, especially in dynamic environments, such as CBI. As a matter of fact, most instructional design models recommend an analysis of the target population to identify specific characteristics of the learners (Gagne, Briggs, & Wager, 1988; Dick & Carey, 1990). As Carrier and Jonassen (1988) point out, information regarding how to use this information in the design and development process is not so readily available. Thus, instructional design research needs to investigate questions about learners and their characteristics in order to determine what type of instructional delivery is best for which type of learner in what type of environment. How learning styles affect students' acquisition of material and their attitudes toward computer-based instruction has been only minimally researched (although largely discussed) in the literature.

Because individuals learn differently it is logical to suppose that some would prefer to learn individually while others would prefer to learn in groups. Carrier, Newell, and Lange (1982) found a relationship between preferences for instructional activities and learning style. Their investigation showed that individuals differed in their preferences for group-oriented activities. Some learners preferred methods which lent themselves well to group work, whereas others preferred methods which utilized individual strategies. Since, Carrier, Newell, and Lange's (1982) work only dealt with learner preferences, the next logical question is whether students actually perform better in these preferred learning environments.

Thus, several questions were raised as to how would achievement and attitudes of students be affected by other intervening variables such as cooperative learning and learning styles within a computer-based learning environment. We asked ourselves would attitudes and performance be enhanced in a cooperative group setting or with independent use of CBI by individuals? Further, we asked would a particular type of learner benefit more by group vs. independent learning in a computer-based lesson?

Background of the Study

Computer-Based Instruction

Research results on computer-based instruction (CBI) provide some guidance for designers.For example, with the abundance of research comparing traditional instruction to computer-based instruction, researchers have found that CBI is as effective or can be more effective in many cases than traditional instruction (Burns & Bozeman, 1981; Niemiec & Walberg, 1985; Kulik & Kulik, 1986; Kulik, Kulik, & Shwalb, 1986; Kulik, Kulik, & Bangert-Drowns, 1985a; Kulik, 1983; Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Cohen, 1980). Kulik, Bangert, and Williams (1983) also reported that, in some cases, retention may be slightly improved.

Another example is in the research on CBI and attitudes. Although some research results have shown no strong effects on attitude (Robyler, Castine, & King, 1988; Dalton & Hannafin, 1988), the majority of findings indicate that CBI tends to improve attitudes with respect to the computer itself (Kulik & Kulik, 1987; Kulik et al, 1986, 1985a, 1983). In addition, it has been reported that CBI can improve attitudes toward the subject matter at hand (Menis, Snyder

& Ben-Kohav, 1980; Kulik et al., 1987, 1986, 1985, 1983), as well toward instruction in general (Atkinson, 1984; Kulik, et al., 1987, 1986, 1985b, 1983).

Cooperative Learning

Johnson and Johnson (1987) define cooperative learning as the instructional use of small groups so that students work together to maximize their own and each other's learning. A variety of methods of cooperative learning abound in the literature and practice (Johnson & Johnson, 1987; Slavin, 1980a, 1980b; DeVries & Edwards, 1974; Kagan, 1985). Each of these methods vary by the number of students per group, type of learning goals and tasks, and the specific training methodology and procedures employed.

The use of cooperative learning techniques in conjunction with CBI has been seen by some scholars as desirable (Dalton, Hannafin, & Hooper, 1989; Hooper & Hannafin, 1988a,b; Johnson, Johnson, & Stanne, 1985; Johnson, Johnson, & Stanne, 1986; Webb, 1987). It has been found that the use of cooperative learning and CBI have had positive effects on performance (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Johnson, Johnson, & Stanne, 1985; Slavin, 1983b; Dalton, Hannafin, & Hooper, 1989). Although much research suggests that computer-based cooperative learning may promote higher performance than individual instruction, these findings are not conclusive. Carrier and Sales (1987) found no differences in the performance scores of students working in groups and those working individually. Similarly, Sherman (1988) found no significant difference between the performance scores of students learning in a cooperative environment and those learning in an individual environment.

In addition to effects on performance, the use of cooperative learning techniques has had positive effects on student attitudes (Mevarech, Stern, & Levita, 1987; Slavin & Karweit, 1981; Johnson, Johnson, & Stanne, 1986). Again it must be noted that not all studies report positive outcomes in terms of student attitudes (Slavin, 1990; Moskowitz, Malvin, Schaeffer, & Schaps,1983; Madden & Slavin, 1983; Slavin, Leavey, & Madden, 1984; Johnson, Johnson, Scott, & Ramolae, 1985).

Although research on the use of cooperative learning in CBI environments have had mixed results, necessity may be the main reason for its continued use in computer environments. Typical computer classroom/lab settings rarely provide each individual student with a computer (U.S. Congress, Office of Technology Assessment, 1988). Thus, if students are to spend a significant amount of time with CBI, they may have to do so as a member of a group (Trowbridge & Durin, 1984). Because of this restriction, effective instructional methods for helping students work in groups needs to be found.

Based on past research it is noted, however, that other intervening factors such as learning style could affect both performance and attitudes of students learning by cooperative methods. For example, Swing and Peterson (1982), in their investigation of student ability and student behaviors during small-group interaction, found that performance was related to student ability. Similarly, Webb (1982) found that performance was related to ability, but in addition to group composition, gender, and personality. Finally, Hall, Rocklin, Dansereau, Skaggs, O'Donnell, Lambiotte, and Young (1988) administered nine individual difference instruments, measuring a number of characteristics. They also found that individual differences may have an effect on performance in cooperative learning situations. One specific individual difference which may affect performance in cooperative group learning is the learning style of introvert and extrovert.

Learning Style

Learning style differences found in individuals may affect both performance and attitudes in cooperative group learning, as well as in individual learning situations. Learning style refers to an individual's characteristic mode of gaining, processing, and storing information (Davidson, 1990). Although some researchers question its usefulness (Cohen, Hyman, Ashcroft, & Loveless, 1989; Sewall, 1986; Freedman & Stumpf, 1980), others advocate the use of learning style information when investigating the instructional process (Davidson & Savenye, 1990; Davidson, Savenye, & Orr, 1992; Dunn, Beaudry, & Klavas, 1989; Gregorc, 1979; Keefe, 1979; Carrier, Newell, & Lange, 1982; Fizzell, 1984; Clariana & Smith, 1988).

To date, there is little research on the relationship of learning style with student performance on CBI. A recent study by Davidson and Savenye (1990; and with Orr, 1992) suggests there is a relationship between learning style and performance on computer-based instructional tasks. Sharma (1987) also found evidence to support the consideration of learning style in the planning of instructional programs. As Sharma points out, the process of identifying individual learning styles and using this information is not a new idea, however, using it in terms of CBI warrants more study.

Likewise, few research studies have investigated the effects of learning style on attitudes, especially in conjunction with a computer-based lesson. However, one study by Charkins, O'Toole, and Wetzel (1985) showed a relationship between learning style and attitude. Canino and Cicchelli (1988) also found a significant difference in attitudes of subjects involved based on their identified learning style. Finally, research by Davidson and Savenye (1990) also suggests that there is a relationship between learning style and attitude in CBI.

Currently, research does not strongly support the consideration of learning style alone as a variable for improving instruction. However, learning style combined with other instructional variables, such as CBI and/or cooperative learning, may provide insight into which instructional strategies are most effective for different types of learners. It is possible that assignment of students to group or individual instruction, based on their style preference, will lead to improved performance as well as improved attitudes.

Statement of the Problem

Based on descriptions provided by learning style instruments, it was hypothesized that some particular learning styles among individuals would prefer working in groups whereas others with differing styles will prefer working individually. Meisgeier and Murphy (1987) offer a learning style instrument that classifies learners as extraverts (Note: Meisgeier and Murphy's spelling of the term), introverts, or undetermined. Because of these differences in learning style, the focus of this research was to study the effects of the learning style of extroversion-introversion in combination with cooperative learning on both performance and attitude in a computer-based instructional environment.

The purpose of this investigation was to determine the implications of instructional delivery (cooperative learning) and learning style (introvert-extravert) for the design of CBI environments. Specifically, the study examined the effects of instructional delivery and learning style on performance, as well as attitudes.

Methodology

Subjects

Subjects were 190 elementary students ranging from nine to twelve years of age in either the fourth or fifth grade at an affluent school district in Austin, Texas. Participation in the study was on a voluntary basis, requiring parental consent. Subjects were randomly assigned to one of six experimental conditions stratified by their individual learning style. Approximately equal numbers of fourth and fifth grade subjects would be assigned to the cooperative group and individual conditions.

Treatment Materials

Cooperative Training. The cooperative learning methodology chosen for this study was Learning Together (Johnson & Johnson, 1975). Learning Together is a cooperative learning method emphasizing five major elements: positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing. Learning Together was chosen based on its ability to be easily adapted to existing curriculum materials. (Note: It was only used with the CGI group.)

CBI Lesson. The instructional materials used in this study included a computer-based tutorial on astronomy, specifically on mapping the night sky. The title of the software was "An Introduction To The Night Sky" (Orange Cherry Software, 1987). Basic principles of astronomy were a part of the existing school curriculum at the fourth and fifth grade level, therefore, the lesson provided a logical extension to the district's required objectives. The software ran on Apple IIe and Apple IIgs machines which were housed in the school computer lab; there were eighteen computers. In addition to the software, the researcher developed a handout of terms and procedures that were included in the program to assist students in pulling out relevant information.

Performance Measures. Performance was measured by a 29-item multiple choice paper and pencil test. The posttest was administered twice--once immediately following instruction and again, one week after instruction with the items appearing in a slightly different. Reliability of the immediate posttest was .75 and delayed posttest .77 (coefficient alpha).

Attitude Measures. Pre- and post-attitude questionnaires were given to assess student attitudes toward receiving instruction through either cooperative group or individual delivery methods. The attitude questionnaire was a Likert-type scale consisting of 8 items. Reliability of the pre-attitude instrument was .77 and .79 for the post-attitude instrument.

Learning Style. The Murphy-Meisgeier Type Indicator (MMTIC) (Meisgeier & Murphy, 1987) served as the measure of individual learning style preference. It is based on the same philosophy and learning theories as the Myers-Briggs Type Indicator but intended for second through eighth grade students. It is a self-report instrument consisting of seventy items.

Cooperative Learning Check Test. The check test, developed by the researcher, served to measure the knowledge of cooperative learning roles and skills. The check test consisted of ten yes/no items and had a reliability of .42.

Cooperative Learning Observation. A supplemental measure of cooperation during the study was taken. An instrument, developed by the researcher, to record observations of cooperative behaviors in groups was used. This was an eight item Likert-type scale to which the observer was instructed to respond as a means to gage a range of cooperation from high to low.

Research Design and Analysis

The design of this study is a factorial design (2 instructional delivery conditions X 3 learning style conditions). The independent variable of instructional delivery had two levels: cooperative group instruction and individual instruction. For the purposes of this study, cooperative group instruction (CGI) was defined as three-member groups working together implementing cooperative learning strategies, such as positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing, to complete the assigned instruction (Johnson & Johnson, 1987). Individual instruction (II) referred to one learner working through the assigned instruction independently.

The second independent variable was learning style, with three levels as determined by the Murphy-Meisgeier Type Indicator for Children (Meisgeier & Murphy, 1987). The three learning styles were: extravert, undetermined, and introvert. This instrument provides cutoff scores which categorize subjects as one of these three types.

Both posttest performance and attitudinal data were analyzed with analysis of covariance techniques (ANCOVA) using school achievement as the covariance. Support data on the cooperative learning skills behaviors (check test and observation record) were also analyzed to determine if skills were understood and used by subjects.

Experimental Procedures

The classroom teachers and the computer lab teacher were taught cooperative learning skills based on the Learning Together Model (Johnson & Johnson, 1987) by the researcher. Lecture and overheads were used to present the information.

Subjects were randomly assigned by the researcher to one of six experimental conditions, stratified by individual learning style. The six experimental conditions, all receiving instruction via computer were:

1. Cooperative Instruction and Extravert (CE)
2. Individual Instruction and Extravert (IE)
3. Cooperative Instruction and Undetermined (CU)
4. Individual Instruction and Undetermined (IU)
5. Cooperative Instruction and Introvert (CI)
6. Individual Instruction and Introvert (II)

Students assigned to CGI group were taught cooperative learning roles and skills by their classroom teachers and given opportunities to practice them for two weeks, 10 minutes per day, prior to attending instruction in the computer lab. A cooperative learning check test was administered prior to the study. A paper and pencil test, following two weeks of cooperative learning instruction, served as a measure of student knowledge of cooperative roles and skills.

The majority of the study took place over a period of three days and in the school computer lab. Because intact classes were used, both groups and individuals were required to work at the same time in the computer lab. On Day 1, subjects were briefly introduced to the study. Cooperative learning roles and skills were reviewed briefly for the CG treatment groups. Subjects received the pre-attitude questionnaire and introduced to the lesson and actual software. On Day 2, after a brief review of general instructions and cooperative learning skills, subjects spent the forty-five minute period interacting with the CBI software. The computer lab teacher monitored the students' behavior and assist them if they had problems with the computers (not the lesson). The researcher and other observer were present to observe the subjects' behaviors in the CG treatments. On Day 3, again after the review, an additional twenty minutes of instructional time was given. At the end of the CBI time, the immediate performance test was administered followed by

the post-attitude questionnaire. One week later, the delayed performance posttest was administered by the classroom teacher.

Summary of Results

Performance

The 2 x 3 x 2 analysis of covariance (ANCOVA) with repeated measures on the last factor revealed no significant differences among the six experimental conditions for performance. There was no significant main effect for instructional delivery, nor was there a significant main effect for learning style. In addition, no significant interaction was found between the two variables. The repeated measures analysis revealed no significant differences between the immediate and delayed performance scores.

Scores on the California Achievement Test (CAT) Science sub-section (covariate) were found to be significant. This indicates that there was a relationship between the covariate (CAT scores) and performance.

Attitude

Analysis of covariance (ANCOVA) revealed no significant differences among the six experimental conditions on attitude. Once again there was no significant main effect for instructional delivery, nor was there a significant main effect for learning style. In addition, no significant interaction was found between the two variables. Scores on the pre-attitude questionnaire (covariate) were found to be significant. This indicates that there was a relationship between the covariate (pre-attitude questionnaire) and attitude.

Support Data

Although no formal hypotheses were formulated for the following analyses, they were areas related to the previously stated hypotheses and served to support or elaborate on the findings associated with them. Mean scores on the cooperative learning check test were above 88% for all six experimental conditions. This information supports the previous research questions and hypotheses in that one can probably assume that subjects had a fairly good understanding of the roles and skills they were supposed to use during the study. Tallies from observations of cooperative learning groups (tallies of roles and skills performed during interaction with the instructional materials) indicated that subjects with an undetermined learning style exhibited the highest use of cooperative roles and skills followed by those subjects with an introvert learning style and finally subjects with an extravert learning style. Differences among the groups were small, however. On an overall rating of cooperation, extravert subjects were ranked highest in terms of cooperation, followed by undetermined subjects, and finally introvert subjects.

In summary, the results of this study failed to support the hypotheses for interaction between instructional delivery and learning style for both performance and attitude. This lack of support may have been due to methodological, rather than conceptual reasons. It is possible that specific details or limitations of this study may have contributed to the lack of significant findings. Based on the inconclusive results, some recommendations for further research and practice are made.

Recommendations for Further Research

Cooperative Learning Instruction

Although it appears that subjects understood the limited number of cooperative learning roles and skills included in this study, not all in the CG treatment group performed the skills automatically. They may not have had sufficient time to practice them in the ten minute periods, nor were they prompted to use these skills during the remaining class periods in order to fully internalize these cooperative learning skills. Derry and Murphy (1986) suggest that new skills, such as these cooperative learning skills, be practiced and prompted for better transfer.

It is recommended that cooperative learning techniques (roles and skills) be taught to subjects participating in a study, such as was the case in this study, rather than assuming subjects already possess this knowledge. However, it is also recommended that this instruction last for a longer period of time before conducting the actual research study. It is recommended that both the overall length of time (two weeks in this current study), as well as the amount of time (ten minutes per day in this study) be lengthened.

Type of Computer-Based Instruction

The current study results are limited to computer-based tutorial environments. It is also suggested that this study be replicated with a different type of CBI. It is possible that the type of instruction may have an effect on the

results found. It is suggested that simulation or problem solving type software be used, since these types of software lend themselves more to discussion between group members than does a tutorial.

Learning Style

It is recommended that more subjects be included in research such as this, where subjects are identified and assigned to experimental conditions based on their individual learning style. This is desired since there is a strong possibility of obtaining disproportionate numbers of learning style types.

Using older subjects is also suggested for further research because their learning style may be more fully developed and stable than the subjects in this current study. In addition, it is recommended that subjects of different socioeconomic backgrounds, as well as subjects with a wider range of ability levels be included. Such variations in subjects would increase the generalizability of the findings.

How the subjects are grouped is another possible area for further research. In this study, by nature of the design, cooperative learning groups were comprised of all one learning style. Another area of possible research would involve having subjects of various learning styles grouped together. Findings different from those obtained in this study may be obtained.

Motivation

Although students performed and completed tasks, their full attention, motivation, and/or interest may not have been on this lesson. It is believed that these characteristics may have been lacking in this study, due to the fact that the research occurred so late in the school year. Conducting research earlier in the year may eliminate this possible problem.

Another motivational issue was the incentive provided to make subjects think it worthwhile to participate in cooperative learning groups. It is recommended that the incentive be made more appealing, so that group members would be more likely to consider it worthwhile to participate, and therefore exhibit more evidence of cooperative learning roles and skills.

Recommendations for Practical Application

Classroom Teaching

Cooperative Learning and CBI. There are still not enough computers to make CBI an integral part of classroom instruction (U.S. Congress, Office of Technology Assessment, 1988; Hannafin, Dalton, & Hooper, 1987). The use of cooperative learning in conjunction with CBI may be one method for solving the problem of lack of computer equipment for students.

Information from this investigation may help school personnel in the decision making process regarding computer hardware and the location of it. One of the primary decisions, at the building level, is whether to have computers centrally located, or to house computers in individual classrooms. The results of this study show no difference in performance or attitude between students working in groups or individually. If it is possible to allow students more access to the computer by working in groups within their individual classroom rather than limited time in a computer lab, according to the results of this study, no significant decrease in performance or attitude should be expected. Therefore, when appropriate, group work may be one way to increase student access to computers.

Learning Style. In terms of learning style, this investigation showed that individuals do differ in terms of learner characteristics. Although no statistically significant interactions were found, this research may serve to encourage educators to continue to identify and recognize individual differences in the classroom. Once these differences are acknowledged, educators may then make appropriate instructional decisions responsive to the needs of their particular students.

Instructional Design

Cooperative Learning & CBI. The combination of CBI and cooperative group instruction offers a unique opportunity for learning. Along with this opportunity, comes implications for instructional design.

For instance, there appears to be a need for software appropriate for group use. Much of the instructional software available was not designed for group use. In addition, instructional design principles should be applied to materials appropriate for groups, regardless of the medium.

Learning Style. A second recommendation is the consideration of the target population. One step in most instructional design models is an analysis of the target population. Although learning style, as a specific learner characteristic, did not produce significant results in this study, consideration of learner characteristics is still an important part of the design process. Possibly learning style, in combination with some other variable, or under different conditions, would produce different results.

Summary

It was the intent of this study to provide information about the effectiveness of computer-based cooperative learning with different types of learners as characterized by their individual learning style. This researcher had hoped to find an interaction between instructional delivery, specifically cooperative learning, and learning style. Although results were not statistically significant, continued research and practice is encouraged in these areas so that teaching and learning may continue to improve. The findings of this study and subsequent recommendations for practice may be useful for instructional designers and classroom teachers to increase performance, as well as improve attitudes of individual learners.

BIBLIOGRAPHY

Atkinson, M. (1984). Computer-assisted instruction: Current state of the art. Computers in the Schools, 1(1), 91-99.

Bracey, G. (1988). Computers and learning: The research jury is still out. Electronic Learning, October, 28-30.

Burns, P. K., & Bozeman, W. C. (1981). Computer-assisted instruction and mathematics achievement: Is there a relationship? Educational Technology, 21(10), 32-39.

Canino, C., & Cicchelli, T. (1988). Cognitive styles, computerized treatments on mathematics achievement and reaction to treatments. Journal of Educational Computing Research, 4(3), 253-263.

Carrier, C., A. & Jonassen D. (1988). Adapting courseware to accommodate individual differences. In Jonassen (Ed.) Instructional Designs For Microcomputer Courseware. Lawrence Erlbaum: Hillsdale, NJ.

Carrier, C., Newell, K., & Lange, A. (1982). The relationship of learning styles to preferences for instructional activities. Journal of Dental Education, 46(11).

Carrier, C. A., & Sales, G. C. (1987). Pair versus individual work on the acquisition of concepts in a computer-based instructional lesson. Journal of Computer-Based Instruction, 14(1), 11-17.

Charkins, R. J., O'Toole, D. M., and Wetzel, J. N. (1985). Linking teacher and student learning styles with student achievement and attitudes. Journal of Economic Education, 16(2), 111-120.

Clariana, R., & Smith, L. (1988, April). Learning style shifts in computer-assisted instructional settings. Paper presented at the meeting of the International Association for Computers in Education, New Orleans, LA.

Clark, R. (1983). Reconsidering research on learning from media. Review of Educational Research, 53(4), 445-459.

Clark, R.(1985). Evidence for confounding in computer-based instruction studies: Analyzing the meta-analyses. Educational Communication Technology Journal, 33(4),249-262.

Cohen, S. A., Hyman, J. S., Ashcroft, L., & Loveless, D. (1989, March). Comparing effects of metacognition, learning styles, & human attributes with alignment. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.

CTB/Mc-Graw-Hill. (1985, 1986, 1987, 1988). California Achievement Test. CTB/McGraw-Hill.

Dalton, D. W., & Hannafin, M. J. (1988). The effects of computer-assisted and traditional mastery methods on computation accuracy and attitudes. Journal of Educational Research, 82(1), 27-33.

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research and Development, 37(2), 15-24.

Davidson, G. V. (1990, April). Matching learning styles with teaching styles: Is it a useful concept in instruction? Performance & Instruction, 29 (4), 36-38.

Davidson, G. V., & Savenye, W. C. (1990, February). Learning styles & attitudes. Paper presented at the meeting of the Association for Educational Communications and Technology, Anaheim, CA.

Davidson, G. V., Savenye, W. C., & Orr, K. L. (1992). How do learning styles relate to performance in a computer applications course? Journal of Research on Computing in Education. 24(3), 348-358.

DeVries, D. L., & Slavin, R. E. (1978). Teams-Games Tournaments (TGT): Review of ten classroom experiments. Journal of Research and Development in Education, 12(1), 28-38.

Dick, W. & Carey, L. (1990). The systematic design of instruction. Glenview, IL: Scott, Foresman and Company.

Dunn, R., Beaudry, J. S., & Klavas, A. (1989). Survey of research on learning styles. Educational Leadership, 46(6), 50-58.

Fizzell, R. (1984). The status of learning styles. Educational Forum, 48(3), 303-312.

Freedman, R., & Stumpf, S. (1980). Learning style theory: Less than meets the eye. Academy of Management Review, 5(3), 445-447.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1988). Principles of instructional design. New York: Holt, Rinehart, & Winston, Inc.

Gregorc, A. F. (1979). Learning/teaching styles: their nature and effects. In Student Learning Styles and Brain Behavior (pp. 19-26). Reston, VA: NASSP.

Hall, R. H., Rocklin, T. R., Dansereau, D.F., Skaggs, L. P., O'Donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. Journal of Educational Psychology, 80(2), 172-178.

Hooper, S., & Hannafin, M. J. (1988a). Cooperative CBI: The effects of heterogeneous versus homogeneous grouping on the learning of progressively complex concepts. Journal of Educational Computing Research, 4(4), 413-424.

Hooper, S., & Hannafin, M. J. (1988b, January). Cooperative learning at the computer: Ability based strategies for implementation. Proceedings of the Annual Meeting of the Association for Educational Communications and Technology, New Orleans, LA. (ERIC Document Reproduction Service No. ED 205 647).

Johnson, D. W., & Johnson, R. T. (1987). Learning together and alone: Cooperative, competitive, and individualistic learning. Englewood Cliffs, NJ: Prentice-Hall.

Johnson, R. T., Johnson, D. W., Scott, L. E., & Ramolae, B. A. (1985). Effects of single-sex and mixed-sex cooperative interaction on science achievement and attitudes and cross-handicap and cross-sex relationships. Journal of Research in Science Teaching, 22, 207-220.

Johnson, R. T., Johnson, D. W., & Stanne, M. B. (1985). Effects of cooperative, competitive, and individualistic goal structures on computer-assisted instruction. Journal of Educational Psychology, 77(6), 668-677.

Johnson, R. T., Johnson, D. W., & Stanne, M. B. (1986). Comparison of computer-assisted cooperative, competitive, and individualistic learning. American Educational Research Journal, 23(3), 382-392.

Johnson, D. W., Maruyama, G., Johnson, R., Nelson,D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin, 89(1), 47-62.

Jonassen, D. (Ed.). (1988). Instructional designs for microcomputer courseware. NJ: Lawrence Erlbaum.

Kagan, S. (1985). Co-op Co-op: A flexible cooperative learning technique. In R. Slavin, S. Sharan, S. Kagan, R. Hertz-Lazarowitz, C. Webb, & R. Schmuck (Ed.), Learning to cooperate, cooperating to learn (pp. 437-462). New York, NY: Plenum Press.

Keefe, J. (1979). Development of the National Association of Secondary School Principals Learning Style Profile. ED 296 440.

Kulik, J. A. (1983). Synthesis of research on computer-based instruction. Educational Leadership, 41(1), 19-21.

Kulik, J., Bangert, R., & Williams, G. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 71(1), 19-26.

Kulik, C., & Kulik, J. (1986). Effectiveness of computer-based education in colleges. Association for Educational Data Systems, 19(2-3), 81-108.

Kulik, J., & Kulik, C. (1987). Review of recent research literature on computer-based instruction. Contemporary Educational Psychology, 12(3), 222-230.

Kulik, J., Kulik, C., & Bangert-Drowns, R. (1985a). Effectiveness of computer-based education in elementary schools. Computers in Human Behavior, 1(1), 59-74.

Kulik, J., Kulik, C., & Bangert-Drowns, R. (1985b). The importance of outcome studies: A reply to Clark. Journal of Educational Computing Research, 1(4), 381-387.

Kulik, C., Kulik, J., & Shwalb, B. (1986). The effectiveness of computer-based adult education: A meta-analysis. Journal of Educational Computing Research, 2(2), 235-252.

Madden, N. A., & Slavin, R. E. (1983). Effects of cooperative learning on the social acceptance of mainstreamed academically handicapped students. Journal of Special Education, 17, 171-182.

Matta, K. F., & Kern, G. M. (1989). A framework for research in computer-aided instruction: Challenges and opportunities. Computers in Education, 13(1), 77-84.

Meisgeier, C. & Murphy, E. (1987a). Murphy-Meisgeier Type Indicator for Children. Palo Alto, CA: Consulting Psychologists Press.

Meisgeier, C. & Murphy, E. (1987b). Murphy-Meisgeier Type Indicator for Children Manual. Palo Alto, CA: Consulting Psychologists Press.

Menis, Y., Snyder, M., & Ben-Kohav, E. (1980). Improving achievement in algebra by means of the computer. Educational Technology, 20(8), 19-22.

Mevarech, Z. R., Stern, D., & Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. Journal of Educational Research, 80, 164-167.

Mickler, M., & Zippert, C. (1987). Teaching strategies based on learning styles of adult students. Community-Junior College Quarterly, 11(1), 33-37.

Moskowitz, J. M., Malvin, J. H., Schaeffer, G. A., & Schaps, E. (1983). Evaluation of a cooperative learning strategy. American Educational Research Journal, 20(4), 687-696.

Niemiec, R. P., & Walberg, H. J. (1985). Computers and achievement in the elementary schools. Journal of Educational Computing Research, 1(4), 435-440.

Okey, J. R., & Majer, K. (1976). Individual and small-group learning with computer-assisted instruction. A V Communication Review, 24, 79-86.

Orange Cherry Software. (1987). An Introduction To The Night Sky. Pound Ridge, NY: A Division of Multi Dimensional Communications, Inc.

Robyler, M. D. (1985). The greening of educational computing: A proposal for a more research-based approach to computers in instruction. Educational Technology, 25(1), 40-44.

Robyler, M. D., Castine, W. H., & King, F. J. (198). Assessing the impact of computer-based instruction: A review of recent research. Computers in the Schools, 5(3-4), 1-149.

Sharan, S., Ackerman, Z., & Hertz-Lazarowitz, R. (1980). Academic achievement of elementary school children in small-group versus whole-class instruction. Journal of Experimental Education, 48, 125-129.

Sharma, S. (1987). Learners' cognitive styles and psychological types as intervening variables influencing performance in computer science courses. Journal of Educational Technology Systems, 15(4), 391-399.

Sherman, L. W. (1988). A comparative study of cooperative and competitive achievement in two secondary biology classrooms: The group investigation model versus an individually competitive goal structure. Journal of Research in Science Teaching 26(1), 55-64.

Slavin, R. E. (1980a). Cooperative learning. Review of Educational Research, 50(2), 315-342.

Slavin, R. E. (1980b). Effects of student teams and peer tutoring on academic achievement and time on task. The Journal of Experimental Education 48(4), 252-257.

Slavin, R. E. (1983a). Cooperative learning. New York: Longman.

Slavin, R. E. (1983b). When does cooperative learning increase student achievement? Psychological Bulletin, 94(3), 429-445.

Slavin, R. E. (1990). Cooperative learning: Theory, research, and practice. New Jersey: Prentice Hall.

Slavin, R. E., & Karweit, N. L. (1981). Cognitive and affective outcomes of an intensive student team learning experience. Journal of Experimental Education, 50, 29-35.

Slavin, R. E., & Karweit, N. L. (1985). Effects of whole class, ability grouped, and individualized instruction on mathematics achievement. American Educational Research Journal, 22(3), 351-367.

Slavin, R. E., Leavey, M. B., & Madden, N. A. (1984). Combining cooperative learning and individualized instruction: Effects on student mathematics achievement, attitudes, and behaviors. The Elementary School Journal, 84(4), 408-421.

Trowbridge, D., & Durnin, R. (1984). Results from an investigation of groups working at the computer. Washington DC: National Science Foundation (ERIC Reproduction Service No. ED 238 724).

United States Congress, Office of Technology Assessment (1988). Power on! New tools for teaching and learning. Washington, D.C.: U.S. Government Printing Office.

Webb, N. M. (1982). Group composition, group interaction, and achievement in cooperative small groups. Journal of Educational Psychology, 74(4), 475-484.

Webb, N. M. (1987). Peer interaction and learning with computers in small groups. Computers in Human Behavior, 3, 193-209.