

Effects of Cooperative and Individual Integrated Learning System on Attitudes and Achievement in Mathematics

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Abstract: The purpose of this study was to determine the effects of a computer-based Integrated Learning Systems (ILS) model used with adult high school students engaging mathematics activities. This study examined achievement, attitudinal and behavior differences between students completing ILS activities in a traditional, individualized format compared to cooperative learning groups.

Integrated Learning Systems (ILS) are advanced computer-based instructional systems consisting of a set of computerized courseware covering several grade levels, content areas, and complex classroom management and reporting features. There are two alternative delivery strategies in ILS: individual (ID) and cooperative (CD). In ID delivery, the system provides on-demand help for immediate feedback – correctives allowing each learner to proceed at his or her own pace (Anderson, Corbett, Koedinger, & Pelletier, 1995). The CD delivery system provides for grouping students into pairs who use the same system cooperatively. In adult high schools these ILS are utilized in computer labs. Either a computer lab assistant or teachers bring their classes into the computer lab, and students work individually on computer-based instructional lessons for an allotted time period. In this implementation model, students do not work cooperatively and are discouraged from sharing information and assisting peers. However, using ILS in this manner has fit the traditional design and pedagogical theory of teaching adult learners. The purpose of this study was to compare the effects of cooperative delivery and individual delivery of ILS instruction on mathematics achievement, attitude and behaviors in adult (16-21 yrs.) high school students (grades 9-12).

Research Design

This study was conducted in an urban adult high school in Miami-Dade County Public Schools using a pre-test/post-test design. Achievement was measured using the Compass Integrating Learning (CIL) and the Test of Adult Basic Education (TABE). CIL is the computer management system that delivers comprehensive data reporting for improved K- 12 student achievement. It's designed to help teachers manage student performance, personalize instruction, and give students engaging, hands-on activities in a stimulating learning environment. CIL focuses on the Florida Sunshine State Standards and curriculum frameworks in mathematics (i.e., Algebra) and is correlated to the objectives covered on the Florida Comprehensive Assessment Test (FCAT) and Test of Adult Basic Skills (TABE). An attitudinal survey was administered to measure attitudes towards mathematics, the computer-related lessons, and group activities. Behavior was assessed using computer lab observations. Two-way analyses of variance (ANOVA) were conducted on achievement (TABE and Compass) by group and time (pre and post). A one-way ANOVA was conducted on the overall attitude by group on the five components (i.e., content mathematics, delivery/computers, cooperative, partners, and self efficacy) and a one-way ANOVA was conducted on the on-task behavior by group.

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Theoretical Perspective

In recent years, many schools have turned to ILS to facilitate instruction and assist with raising state standardized test scores (Becker, 1994). In earlier studies (e.g., Mandle & Lesgold, 1988), ILS was predominantly implemented in elementary schools, and few in secondary schools. With educational reform impacting the perceptions of work by both the clients and social service agencies, and a growing awareness of what is needed to succeed in continuous education and/or the work force during the next decade, dramatic instructional changes need to be implemented in adult education. The theoretical perspective for this study was based on the following themes: (a) cooperative learning versus traditional learning; (b) computer-assisted instruction versus traditional learning; (c) integrated learning systems (ILS); (d) cooperative delivery (CD-ILS) versus individual delivery (ID-ILS); (e) CD-ILS versus ID-ILS effects on achievement; and (f) CD-ILS versus ID-ILS effects on attitude and behavior.

Cooperative Learning vs. Traditional Learning

Cooperative Learning (CL), an alternative to traditional learning, is a group-initiated mode that attempts to establish individual accountability within a group (Slavin, 1995). CL is a method of facilitating interdependence among students. CL involves the entire spectrum of learning activities in which groups or dyads of students work together in or out of class. It can be as simple and informal as pairs working together in a Think-Pair-Share procedure, in which students consider a question individually, discuss their ideas with another student to form a consensus answer, and then share their results with the entire class. Johnson, Johnson, and Taylor (1993) suggest that cooperative learning students learn more material, feel more comfortable about them and are more motivated to learn and more accepting of differences among peers. In contrast, traditional teaching has evolved into a system of having students work alone, with a subtle (and sometimes not so subtle) competition among students (Jensen, Johnson & Johnson, 2002). Some research defines CL as a learning situation in which students working in groups can achieve the goals of an instructional activity only if the other students with whom they are working achieve the goals as well (e.g., Deutsch 1962; Jensen et al., 2002). This can be contrasted to individualistic learning in which students' achievement of goals is not dependent on other students' work, and thereby predicting that CL will promote higher achievement than competitive or individualistic learning and promote individual accountability (Yager, Johnson, Johnson & Snider, 1985).

Computer-assisted Instruction (CAI) vs. Traditional Learning (Teacher-directed)

The best-documented findings in the research literature support the use of Computer Assisted Instruction (CAI) as a supplement to traditional, teacher-directed instruction. CAI produces achievement effects superior to those obtained with traditional instruction alone. A meta-analysis conducted by Kulik, Kulik and Bangert-Drowns (1985) compared achievement levels of students who received computer-assisted instruction to those of their peers who did not receive computer instruction. The analysis concluded that computer-based instruction generally increased the achievement levels of elementary students and that computer instruction significantly raised student achievement scores. It also concluded that when students are successful, they view the subject matter with a very positive attitude because their self esteem is enhanced. A follow-up meta-analysis of 254 studies looked at the effects of computer-based instruction on achievement and found that less instruction was needed with the computer and that students tended to have a more positive attitude toward courses that included computer instruction (Kulik et al., 1985). Sivin-Kachala (1997) reported similar findings in a meta-analysis of 219 studies that examined the effects of the computer on student achievement.

However, the evidence favoring computers is not conclusive. Clark (1994) challenged claims that computer-based instruction increased the achievement levels of students and argued that the instructional methods used by teachers, the attributes of the academic task, and the student herself/himself are the real causes of any measurable differences in student achievement.

Integrated Learning Systems

ILS is part of a new breed of instructional computer programs that utilize recent developments in computer memory, computational speed capabilities, new computer programming languages, and research in human cognition and learning. An ILS is a computer-based learning system designed to help users develop specific skills, such as literacy and numeracy (Becker, 1994). Through expert system technology and artificial intelligence, ILS is able to carry on intelligent "dialogues" with students and flexibly adjust to the knowledge and skill level of individuals. It can also provide a variety of methods of representing and accessing information (Mandle & Lesgold, 1988). Some systems are oriented to discovery-learning, while others are more didactic, or "teaching" oriented. Compared to earlier computer-assisted instructional tools, they are far more adaptive to individual students and better matched with current goals in mathematics education (Mandle & Lesgold, 1988, p. 26). Key decision makers in schools responsible for introducing ILS into school programs believe that ILS are effective in raising standardized test scores for high and low achievers, older students, and students who have difficulty in learning from traditional classroom-based methods (Brush, 1997). In recent years, many schools have turned to ILS to facilitate instruction and assist with raising state standardized test scores (Becker, 1994).

Cooperative Delivery ILS vs. Individual Delivery ILS (CD-ILS vs. ID-ILS)

Research studies have concluded that ILS has a positive impact on academic achievement (e.g., Clariana, 1996). However, many researchers also believe that the academic impact of ILS does not make up for the investment in monetary and personnel resources needed to purchase and maintain these systems. Becker (1994) conducted meta-analyses of numerous studies examining the academic impact of ILS and found that ILS had only moderate effects on student achievement. Maddux and Willis (1992) also cautioned that research regarding ILS and academic achievement was inconclusive and that further study was needed in this area. With all these practical problems related to effective use, it is not surprising that consistent results are not obtained indicating effectiveness from classroom to classroom and school to school. Effectiveness of an "automated" system such as ILS may depend upon the mindfulness with which it is used (Becker, 1994). A comparative study of the impact of ILS on students' time-on-task (Worthen, Van Dusen & Sailor, 1994) indicated that students using the ILS spend more time actively engaged in the learning tasks than students in the non-ILS classroom. Mevarech (1994) examined the effects of a computer-based ILS implemented individually vs. cooperatively for mathematics achievement and found that students who used the system cooperatively outperformed their counterparts who used the system individually.

CD-ILS vs. ID-ILS Effects on Achievement

Although ID-ILS has a positive impact on academic achievement, its implementation presents a number of pedagogical and logistical constraints related to a lack of consideration for its effects on attitudinal development (Becker, 1994). It has been criticized for de-emphasizing affective outcomes (Mevarech, 1994), increasing anxiety and hostility toward the subject matter (Brush, 1997), fostering disinterest and increased off-task behaviors, and decreasing teacher interaction with students (Becker, 1994). Presumably, these attitudes tend to decrease the academic effectiveness of ID-ILS (Mevarech, 1994). In a model for CL-ILS, Brush (1997)

provides for inclusion of positive interdependence, individual accountability, and collaborative skills. CL, compared to ID, leads to better performance on tests of basic mathematics skills and higher level mathematics concepts. Similarly, ILS dyads outperformed students completing the same activities individually. Brush (1997) found that Jostens's (now Compass Learning) mathematics curriculum in a cooperative-oriented environment resulted in higher performance on standardized mathematics tests than in an individual-oriented environment. The cooperative group also developed more favorable attitudes toward mathematics.

CD-ILS vs. ID-ILS Effects on Attitude and Behavior

Johnson, Johnson, and Taylor (1993) compared the effects of individualistic and cooperative learning on the attitudes and achievement of high-ability students and found that high-ability students demonstrated higher academic self-esteem and greater cohesion in the cooperative condition. CL experiences in mathematics classrooms foster improved attitudes toward the subject and increase students' confidence in their own ability to do mathematics (Brush, 1997). There is considerable evidence that student-teaming techniques, such as those defined by Johnson et al., (1993), are effective for increasing social interactions. Positive goal interdependence resulted in more task-oriented interaction and more supportive relationships with peers, inter-racial relationships, and mutual concern (Sharan & Sharan, 1992). There is still much debate about the merits of these methods as a means of developing cognitive skills. Although CL may be beneficial for some students, it has several drawbacks. One such drawback is the lack of systemic feedback (corrective procedures). Teams, as performing units, may make an error and be unaware of it because they may not be supported with informative responses. CL-ILS provides additional opportunities for teams to remediate difficulties experienced by students in encountering tasks. Research shows that cooperative learning can have a positive impact on students' social behaviors and attitudes toward instructional content (Brush, 1997).

There is still much debate about the merits of CL-ILS and ID-ILS as a means of developing cognitive skills. Although some researchers revealed greater achievement gains under cooperative situations, other researchers have urged the use of individual and competitive structures, or have found no significant differences on achievement tests between cooperative and non-cooperative conditions. This review of literature has provided both broad and deep coverage of the history of traditional computer-assisted learning and current integrated learning systems structures. The present study will identify differences in achievement and in attitudes as a consequence of instruction in CD-ILS vs. ID-ILS. In addition, the study will discover the reasons for differences in outcome of cooperative and individual delivery ILS due to different task behaviors elicited under the two conditions.

Findings

Research has shown that combining CL with ILS-delivered instruction is an effective instructional strategy (Brush, 1997). However, the question of which types of grouping strategies are most appropriate with adult high school students when using ILS is still open to debate. Findings from this study demonstrate that the CD-ILS group had a higher mean adult GPA. There was a difference from pre to post test TABE scores of students in both the ID-ILS and the CD-ILS groups. However, neither group improved more than the other. In terms of the Compass, mathematics achievement under the CD-ILS method of instruction showed no differences from the ID-ILS from pre to post. Responses to the questionnaire revealed attitudinal differences between students in the two groups, particularly in terms of higher agreement scores on cooperative and partner method of instruction in CD-ILS group over the ID-ILS group. The CD-ILS group was on task less than the ID-ILS group. The CD-ILS students had significantly

better overall mathematics attitudes than the ID-ILS students and the ID-ILS group was on task significantly more than the CD-ILS group.

In addition, cooperative group structure did not have a significant impact on achievement. Statistical results of the data support the research question that CD-ILS grouping is greater with partners and cooperative groupings, and that students prefer to work on mathematics activities with a partner. The partners help each other to understand mathematics and partners assist each other with completing their lessons on the computer. Additionally, adult high school students attend school primarily in the evening, which does not allow sufficient time for true collaboration to occur or for group members to establish trust and a sense of group security.

Conclusions and Implications

As a result of this study, two conclusions for adult high school mathematics teaching and learning arise. First, a minimum amount of time-on-system is necessary before gains can become apparent in innumeracy, and increasing exposure to the system has beneficial effects on learning. Regularity and period of time over which the ILS is used may also prove to be an important variable although there were insufficient data to fully investigate the impact of models of use. Students are generally positive about working with the ILS. There is qualitative evidence of the transfer of positive attitudes for mathematics (e.g. Brush, 1997). Secondly, the desire to achieve the “American Dream” of a high school diploma is one that often goes unrealized for many adult students. When developing programs for adult students, adult and career and technical educators must create ways of developing balanced programs while still meeting the requirements of legislation. Although all ability groups benefited from use of ILS, the ILS did not preferentially benefit one ability group over another any more or less than would be found for any teaching intervention.

There is limited empirical evidence on the effectiveness of CL as it relates to learning outcomes in adult education. However, research at the primary and secondary levels reveals that students learn better through noncompetitive, collaborative group work than in classrooms that are highly individualized and competitive. Whether or not this is true with adults is still largely untested and needs further research. Consequently, there is a need for closer examination of the academic effects of ability grouping with ILS-delivered instruction. A study with an extended treatment time or with a larger sample size to include several sites may produce different results from those reported here. When developing programs for adult students, adult and career and technical educators need to focus on the critical need for students to acquire skills and empower them to get their basic education requirements. These planners need to create ways of developing balanced programs while still meeting the requirements of legislation. In our current millennium generation, this amounts to a high school diploma plus some post-secondary educational experience.

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