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ABSTRACT

This study investigated the following research questions: (1) Does the use of a shared, intranet environment improve learner problem-solving ability in science? (2) Does the use of a shared, intranet environment increase learner metacognitive reflection? and (3) Do gender differences emerge with the use of a shared, intranet science environment for problem-solving ability and metacognition? A quasi-experimental design randomly assigned 9th and 10th grade biology classes to traditional or shared intranet learning environments. Pilot-test World Wide Web-based distance education software created the simulated intranet learning environment and provided user movement tracking ability, while the visual learning software, Inspiration, was used to generate concept maps and measure learner metacognitive reflection. A modified ecology curriculum provided contextualization and science content for the shared, intranet and traditional learning environments. This shared, intranet learning environment posed one model which science classrooms can use to create equal opportunity for both genders. Tracking learner movements within a Web-based, science environment has metacognitive as well as problem-solving implications for all learners. (AEF)

Research Paper: Using Technology to Facilitate Learning

Are Academic Behaviors Fostered in Web-Based Environments?

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Key Words: **intranet, Web-based learning, metacognitive reflection, problem-solving ability**

This study investigated the effects of a shared, intranet science environment on the academic behaviors of problem-solving and metacognitive reflection. A quasi-experimental design randomly assigned biology classes to traditional or shared, intranet learning environments. Pilot-test Web-based distance education software created the simulated intranet learning environment and provided user movement tracking ability, while the visual learning software, Inspiration, was used to generate concept maps and measure learner metacognitive reflection. A modified ecology curriculum provided contextualization and science content for the shared, intranet, and traditional learning environments.

Data analysis suggested movement toward weak support for differences in problem-solving group means. Significant support, at the .001 level, for increases in problem-solving ability resulting from use of a shared, intranet learning environment was seen when individual differences, as measured by paired analysis, were employed. Analysis indicated significant support for improved metacognitive reflection across number of concepts (.04) and number of concept links noted (.04), but not for number of concept nodes. Use of the visual learning tool within the shared, intranet learning environment significantly improved reflective thinking in learners. Analysis of gender differences in problem-solving ability and metacognitive reflection indicated no significant differences. Lack of gender differences in a shared, intranet environment seemed contradictory. However, the cooperative, collaborative nature of an intranet environment revealed itself. Such environments appealed to, and ranked high with, the female gender. Lack of significant gender differences strongly suggested an equalizing effect.

This shared intranet learning environment posed one model which science classrooms can use to create equal opportunity for both genders. Tracking learner movements within a Web-based, science environment has metacognitive as well as problem-solving implications for each and every learner.

Introduction and Rationale

As the intranet (Dede, 1997; Jonassen, 1995, 1996) is introduced into the learning environment (James, 1996; Ryser, Beeler & McKenzie, 1995) comprising the classroom today, the effects of this technology must be investigated (Ryder & Wilson, 1994, 1995, 1997; Schneider, 1994). Technology offers opportunity to affect academic behaviors such as problem-solving ability and metacognitive reflection (Brooks & Brooks, 1993; Driscoll, 1994; Jonassen, 1996; Papert, 1993).

As technology moves to a Web-based environment (Jacobsen & Levin, 1993; Ryder & Wilson, 1994; Soltesz, 1996), research must be conducted to determine the effectiveness of geographically unrestricted, collaborative problem-solving (CSILE, 1996). This type of collaboration (Cox, 1997; Hewitt, 1997; Ravitz, 1995; Ryser, Beeler, & McKenzie, 1995) becomes possible when the learning environment is placed on a networked (Miller, Chaika, & Groppe, 1996; Strommen & Lincoln, 1992) Web of computers, thereby facilitating access by many to the same place on the intranet (BlackBoard, Inc.).

As students use the collaborative capabilities of a networked intranet learning environment (Waugh, Levin, & Smith, 1992), thinking about their own thinking evolves (James, 1996; Jonassen, 1996; Papert, 1993), thereby increasing the opportunity to clarify misconceptions of knowledge, procedural or declarative (Mestre, 1996). The science classroom presents one opportunity to study the effects of a shared, intranet environment on student problem-solving ability and metacognitive reflection skills (Knezek, Southworth, Christensen, Jones, & Moore, 1995; Mestre, 1996; Pea & Gomez, 1992; Sinkpen, 1996; Slough & McGrew-Zoubi, 1996).

The purpose of this study was to investigate the effectiveness of a shared, intranet learning environment on problem-solving ability and reflective metacognition in 9th–10th grade biology students. As gender differences emerged within this shared, intranet environment, they were studied (Miller, et al., 1996).

Because students constitute all classrooms today, the effect of learning environments upon differing cognitive abilities was tested. Students enabled data collection that addressed the effect a shared, intranet learning environment had on the academic behaviors of students, specifically problem-solving ability and metacognitive reflection.

Research Questions

1. Did the use of a shared, intranet environment improve learner problem-solving ability in science?
2. Did the use of a shared, intranet environment increase learner metacognitive reflection as evaluated by Web-based CourseInfo software, tracking capabilities within a threaded discussion site and measured by concept mapping from visual learning software (Inspiration) to determine changes in learner thinking patterns?

3. Did gender differences emerge with the use of a shared, intranet science environment for problem-solving ability and metacognition?

Methodology

Subjects

Subjects for this study were first time 9th and 10th grade biology students from three public education high schools in the Conroe ISD within Conroe, Texas. The sample (n) contained 78 students of the 1,400 students enrolled in Biology I courses. Two classes from each school were selected and randomly assigned as a control class or a treatment class. Selected campuses operated on an A-B, 90-minute class alternating block schedule. Classes operating on this type of schedule met three days per week and two days per week, alternating every other week. The sample population included male and female subjects.

Technology

Groups assigned to treatment groups received access to technology. This technology included Macintosh platform computer labs or classroom computers. All treatment groups had access to at least 6 and at most 10 computers.

Scanners, digital cameras, Internet-connected computers, and laser printers rounded out the technology utilized by the treatment groups. Software accessed included Apple QuickTake photo software, HP scanning software, Microsoft Office 95, Netscape Navigator 3.0, and Inspiration 4.0.

Ecology Curriculum

To limit any physical risk, each teacher at selected campuses received an Adopt-a-Ditch ecology curriculum (SeaGrant, 1996). The researcher provided training for all curriculum lessons, use of LaMotte Freshwater Testing Kits (LaMotte, Inc.), Web-based database (BlackBoard, Inc., 1998), and administration of all pre and posttesting instruments. Intentional intranet discussion forum topics were generated by teachers and the researcher during the training sessions. Spontaneous forum topics were noted as the researcher analyzed collected data.

Teacher Training

Training took place over a 3-day time period, for 2 hours each day. An additional 1.5 hour on-site training session ended the teacher training. All training occurred prior to research initiation. Each teacher received complimentary computer diskettes upon completion of each training session.

Technology training consisted of instruction and practice in the use of the CourseInfo intranet simulation software, Inspiration, uploading and downloading files via the Internet, digital camera use, downloading of images, use of Excel spreadsheet/graphics capabilities, and use of the discussion forum environment within the Web-based environment.

All teacher training sessions involving the LaMotte Freshwater Testing Kit focused on MSDS safety sheets, general safety practices, disposal of used testing solutions, disinfecting procedures following fieldwork, understanding each freshwater test, and practicing testing techniques (Flinn, 1997; LaMotte, Inc.; Levine & Miller, 1989). All teachers received a pail of kitty litter for use during the study. The highest standard of safety was established by each teacher in the study and maintained for all class sessions as necessitated by the curriculum content.

Training involving discussion and overview of the ecology curriculum document was incorporated into each training day. Both treatment and control version curriculum documents were used in the training.

Instruments

Treatment and Control groups were randomly assigned at each campus by the principal investigator. Treatment and control groups at each campus were taught by the same teacher. Several instruments were used to discern problem-solving ability and metacognitive reflection in both groups.

Problem-Solving Ability

The Watson-Glasser Critical Thinking Appraisal was used to measure student's problem-solving ability (Psychological Corp., 1990). The Watson-Glasser was selected due to its ability to measure certain aspects of critical thinking, including the ability to 1) recognize problems, 2) evaluate evidence cited to support claims for truth, 3) reason inferentially, and 4) apply the preceding to problems. The test included norms for high students which were developed systematically for this grade level. The reading level was ninth grade and the mental skills it demanded were probably above that. The test was administered in a group setting and was timed at 40 minutes, which fit the campus classroom schedule of the treatment and control groups. Validity of the test was more than acceptable when assessing instructional programs. Evidence supported several aspects of the construct validity of the Watson-Glasser instrument.

Metacognitive Reflection

In the treatment group, this behavior was measured through use of student-generated concept maps developed through Inspiration (Inspiration Software, Inc., 1994), the visual learning software program. Differences targeted included: 1) the number of concept circles generated, 2) the number of links between concept circles, and 3) the number of concept nodes between pre and post concept maps. Metacognitve reflection was also evaluated by 1) logons to the threaded discussions Web page, 2) number of threaded statements, 3) number of threaded dialogue statements of response to other student statements, and 4) number of threaded dialogue statements of response to teacher statements.

Subjects in the control groups generated pretest as well as posttest flowcharts for reflection on changes in thinking connections and patterns by using hand-drawn maps. These changes targeted: 1) the number of concept circles, 2) the number of

links between concept circles, and 3) the number of concept nodes between pre and post concept maps.

Preliminary Findings

In answering the first question, "Did the use of a shared, intranet environment improve learner problem-solving ability in science?" the data did not provide support. While groups did not differ significantly in terms of problem-solving ability, results from t-Test analysis supported movement toward significant differences as a result of exposure to the shared intranet environment. Significant support for increases in problem-solving ability were seen when individual differences, as measured by paired analysis, were employed. Given the individual nature of problem-solving ability, these findings suggested even clearer support for the use of collaborative, constructive, and connected technologies in impacting problem-solving abilities. Use of these technologies within the framework of the science classroom (because of the problem-based opportunities) appeared productive and naturalistic. By providing the contextualization for meaningful inquiry (Brown, et al., 1989; Burbules & Callister, 1996; Cox, 1997; CSILE, 1989; Gokhale, 1995; Jonassen, 1996; Ravitz, 1995; Spiro, et al., 1991; Strommen & Lincoln, 1992; Wilson, 1995), meaning-making thrived and re-application of that meaning to new, problematic situations increased. Problem-solving ability, or critical thinking, moved toward improvement when supported by technologically-created shared, learning environments.

The question of length of exposure within this environment became an important one. Much research supported lengthy time periods of exposure to shared learning environments as methods connected to increased problem-solving ability (CSILE, 1989; Ryser, Beeler, & McKenzie, 1995). Yet, exceptionally small numbers of studies have documented the effect of compacted time periods focused on increasing problem-solving abilities (Abeygunawardena, 1997). A limitation of this study appeared initially as the short time frame allotted to the study. However, the study's allotted time frame represented the reality of many science approaches currently in use. The findings of this study became more relevant given that the design methodology mirrored classroom realities. The significant findings for paired differences can continue to be studied, but should also be taken as one potential method for increasing problem-solving ability through technology. While this study did not address all possible questions of what increased problem-solving ability, it did examine one particular model, that of a shared, intranet science learning environment. Through this examination, favorable results indicated the potential this environment has as one method for improving problem-solving ability. As the length of time was considered with the improvement of problem-solving ability, one continued to ask if something else was at work contributing to this increase in problem-solving ability, over this short duration. This point led to the discussion of the second research question.

Data analysis in addressing the second question indicated significant support for improved metacognitive reflection across number of concepts, number of concept links, but not number of concept nodes. Use of the visual learning tool generating concept maps within the shared, intranet learning environment significantly improved the amount of reflective thinking learners engaged in as indicated by the

results. Both group means and paired analyses supported significant changes in metacognitive reflection.

The power of metacognitive reflection has been well-documented (Anderson-Inman & Zietz, 1993; Collins & Brown, 1986; Gordon, 1996; Jonassen, 1996; Polnick, 1997; Sweany, McManus, Williams, & Tothero, 1996). The construction of individual representations allowed learners to monitor and facilitate their own problem-solving (Gordon, 1996). The process of metacognitive reflection appeared to become inextricably connected to problem-solving ability, as others have suggested (Gordon, 1996; Jonassen, 1996; Polnick, 1997). Add to this process the multiplicative power afforded by a shared, intranet learning environment, and the element of time, as linked to improved problem-solving ability, appeared to become compacted. The results of this study robustly supported the use of visual learning software (concept mapping tools) within a shared, intranet learning environment to improve metacognitive reflection and movement toward improved problem-solving ability.

The robust results of improvement of metacognitive reflection within the shared, intranet learning environment and the interwoven connection to problem-solving ability suggested a model for the improvement of problem-solving ability within shorter time frame constraints. Additional research seemed unwarranted, but perhaps worthwhile.

Analysis of gender differences in problem-solving ability and metacognitive reflection indicated no significant differences. Group means and paired analyses for problem-solving ability and metacognitive reflection showed no differences with the shared, technology-supported science setting. At first glance, these findings shaped themselves as contradictory to landmark gender studies (AAUW, 1992; Campbel & Storo, 1994). However, when the shared, intranet environment was scrutinized, a cooperative and collaborative nature revealed itself. Environments of this type seemed to appeal, and rank high, with the feminine gender (Jones, 1991; Martinez, 1992; Miller, et al., 1996). The lack of significant gender differences in problem-solving and metacognitive reflection resulting from the shared, intranet learning environment strongly suggested an equalizing effect (Loyd, 1989). This shared technology-supported learning environment posed one model which science classrooms can use to create equal opportunity in scientific endeavor for both genders. At the very least, the lack of significant differences as a result of the environment presented a potential model of improvement of problem-solving ability and metacognitive reflection which crossed all boundaries of gender.

Future Implications

The results of this study presented one practical model for infusing technology into the classroom setting, for improving problem-solving ability and metacognitive reflection over a short duration, for creating a collaborative, cooperative learning space, and for maintaining a science space for learning where no gender differences arose.

The power an intranet offered within the constraints of a school district, or geographic locale, have yet been tapped. This study proposed one mechanism for doing just that, given the infrastructure present or absent through use of a Web-

based intranet. This model offered a "get your feet wet" method of networked connectivity for classrooms and teachers who have not yet jumped into the World Wide Web.

This research provided a study in contextualizing connectivity with end goals of improved problem-solving and metacognitive reflection. Both of these elements were often lost when initial attempts to jump into networked learning have been contemplated. Further, this study provided an avenue of documenting the nature of learning during the use of Web browsing or other networked connections. Tracking learner movements within a browsed Web site has metacognitive as well as problem-solving implications for each and every learner.

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