

# Using Database Technology In The AIS Classroom: Effects On Learning And Student Satisfaction

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## ABSTRACT

*The purpose of this study is twofold. First, we examine the effects of using database technology in the classroom on students' acquisition of database knowledge and performance on relation normalization tasks. Second, we solicit students' views on this methodology to determine their satisfaction. Our results suggest that designing an active learning exercise that allows students to interact with a database management system during class improves knowledge acquisition, the ability to apply knowledge, and satisfaction with the course and the instructor.*

## INTRODUCTION

Knowledge of database design is rapidly becoming a critical skill for accountants and auditors. Just as the accounting equation is the backbone of financial accounting, database systems are the foundation of accounting information systems. Database design knowledge is essential for understanding contemporary accounting information systems, business processes, and system controls. Relation normalization represents a key (and complex) component of learning database design. Unfortunately, accounting students have historically had great difficulty acquiring normalization skills, and the database components of AIS courses are often blamed for lower student evaluations in AIS courses relative to other accounting courses.

The purpose of this study is twofold. The first objective is to examine the effects of using database technology in the classroom on the acquisition of relation normalization knowledge and skills. This research proposes that active, in-class use of common database products (e.g., Microsoft Access) can be employed to both demonstrate database topics (such as database anomalies) and significantly enhance learning and performance. Our second objective is to measure the extent of student satisfaction regarding this type of teaching methodology.

Our results suggest that hands-on experience with a database during class presentations improves student learning, student performance, and student satisfaction. Compared to students who received only lecture and case examples, the students who received lecture, combined with hands-on use of database technology, acquired more declarative knowledge<sup>1</sup> and performed better on normalization tasks. In addition, students with hands-on experience during lecture indicated that they were more satisfied with the course and the instructor.

The remainder of the paper proceeds as follows. First, we identify relevant literature and develop the hypotheses. The following section describes the methods and our results. The final section concludes the paper with a discussion of the results, limitations of the study, and suggestions for future research.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Active participation helps improve learning performance because students use more effort to understand the learning environment when they must participate in the process (Thompson et al. 1992). According to Bonwell and Eison (1991), active learning can be defined as anything that involves students in doing things and thinking about the

things they are doing. That is, less emphasis is placed on transmitting information and more on developing students' skills – they are engaged in higher-order thinking (e.g., analysis, synthesis, evaluation).<sup>2</sup>

A number of studies have been reported in the accounting literature on the topic of active learning. For example, Lightbody (1997) uses a factory simulation exercise to help students learn management accounting concepts. Cook and Hazelwood (2002) developed a game, similar to one seen on television, to create an enjoyable environment for students to learn the more technical aspects of accounting.

Several studies have reported *the use* of technology in accounting courses, such as generalized audit software (e.g., Nieschwietz et al. 2002; Gelinis et al. 2001), but few studies have examined *the potential benefits* of in-class technology use, with the exception of studies of multimedia presentations (e.g., Butler and Mautz 1996; Rose 2001). However, a number of researchers in statistics have examined the synergistic effect of combining lectures with technology.

For example, Basturk (2005) compared the learning outcomes of two groups of students who were enrolled in an introductory statistics course. The first group experienced lectures-only classes, while the second group (experimental group) had lectures plus a computer-assisted instruction (CAI) section. Reviews of the students' exam scores indicated that students in the experimental group achieved higher average scores than students in the lecture-only classes. Further, when the course topics moved from descriptive statistics to inferential statistics, the learning gap between the two groups widened, with the experimental group out-performing the lectures-only group. Similarly, Worthington et al. (1996) examined the use of CAI as a supplement to lectures in an introductory psychology class and found that computerized study guides can impact and improve students' overall level of understanding.

Bryant and Hunton (2000) proposed seven guidelines for the effective use of technology in the classroom.<sup>3</sup> We generally followed these guidelines to design our in-class Access database exercise (see Appendix). For this exercise, half of the students received a brief lecture on database anomalies and viewed specific examples of anomalies that could result from improperly designed relations on PowerPoint slides (entirely lecture). The remaining subjects received the identical brief lecture and examples, but were required to input the examples into an Access database that was created for the class (lecture plus technology). Students in this second group who used the database technology received rapid feedback because their inputs resulted immediately in visible anomalies.

By allowing students to actively use a database that produces common anomalies, students can directly witness the results of improperly designed relations and must be actively engaged in the learning process. Use of the database technology should improve learning and subsequent task performance even when traditional lectures and cases cover exactly the same examples. Accordingly, we test the following hypotheses:

**Hypothesis 1:** Active experience with database technology will result in more acquisition of normalization knowledge relative to traditional classroom lectures and lecture-based demonstrations of the same material.

**Hypothesis 2:** Active experience with database technology will improve performance on subsequent normalization tasks relative to traditional classroom lectures and lecture-based demonstrations of the same material.

Prior psychology research has found that students possess individual differences in preferences for verbal explanations of topics and image-based representations (Paivio and Harshman 1983). These researchers used the Individual Difference Questionnaire (IDQ) to measure these differences. The IDQ is an 86-question (True-False) instrument that provides both a verbal score and an imagery score. The imagery score reveals an individual's tendency to rely on images and non-verbal strategies for learning. Imagery-oriented subjects should benefit more from the interaction with the database because they have a greater need to see and visualize the consequences of anomalies in order to learn them. This suggests the following hypotheses:

**Hypothesis 3a:** Active experience with database technology will result in more acquisition of data normalization knowledge for subjects with high imagery scores than for subjects with low imagery scores.

**Hypothesis 3b:** Active experience with database technology will improve performance on subsequent normalization tasks more for subjects with high imagery scores than for subjects with low imagery scores.

Finally, active engagement in the learning process and the other benefits of interacting with the database technology are expected to increase student satisfaction with the course and the instructor. Bonwell and Eison (1991, p. 33) claim that a wide variety of active learning strategies are available and have proven to be effective in promoting students' achievement, in enhancing students' motivation, and in improving students' attitudes. For example, these authors cite several studies that suggest lengthy lectures are not conducive to efficient learning and that as the emphasis of a course moved from lecture to more active forms of learning, more students seemed to approve of the course (p. 10). Other studies also report positive responses of students to active learning exercises, as well as a tendency for students to bond with both their instructor and classmates (e.g., Cook and Hazelwood 2002). These findings suggest the following hypotheses.

**Hypothesis 4a:** Students will be more satisfied with lectures that include hands-on experience with database technology than lectures without technology use.

**Hypothesis 4b:** Students will give higher evaluations to an instructor when lectures include hands-on experience with database technology than when lectures have no technology use.

## **METHOD**

### **The Participants**

The 66 participants in this study were undergraduate accounting students enrolled in two sections of an Accounting Information Systems course. All participants completed the course with the same instructor and the same topics were covered in both sections of the AIS class. The only difference between the two sections was the use or non-use of database technology to explain database relation normalization. The average participant's accounting GPA was 2.85, and 61% of participants were male. All students included in the analysis had completed an intermediate accounting course and no participants had prior database experience.

### **The Experimental Design**

The quasi-experiment<sup>4</sup> used in this study investigated the effects of interaction with an Access database during instruction on knowledge acquisition, performance on subsequent normalization tasks, and satisfaction. All participants received an introductory lecture and handouts covering normalization procedures from the same instructor. After normalization instruction was complete, participants were provided with examples of database anomalies (i.e., undesirable consequences of non-normalized relations). The instructor provided these examples of anomalies on PowerPoint slides to the lecture-only group. However, the lecture-plus-technology group was required to input the examples into an Access database that was created for the class, and designed to produce the same anomalies as those viewed on PowerPoint slides by the lecture-only group.

Each time students in the lecture-plus-technology group made an input, the resulting anomaly became apparent, providing immediate feedback. By interacting with the database system through input and instant feedback, students were cognitively and physically engaged, and they were able to personally experience the consequences of improper normalization (for example, they were unable to update an item description). These students' input and the resulting anomalies were identical to the input and anomalies described in the PowerPoint slides.

The participants in the lecture-plus-technology group did not view the PowerPoint slides that were shown to the lecture-only group. That is, the lecture-plus-technology group did not receive the same information in multiple forms, eliminating the possibility that improved learning or performance could result from presenting material in multiple modes. The only difference between the two treatments resulted from interaction with the Access database. That is, database users were actively engaged with the technology (Access database) and were able to immediately

experience feedback in the form of actual anomalies, while the lecture-only participants listened to and viewed a description of the inputs and resulting anomalies on slides.

During the next class session following the session on normalization procedures with anomaly examples, both groups of participants completed two tests. The first test was a direct examination of students’ knowledge of anomalies. Participants were asked to define insert, delete, and update anomalies and create specific examples for each type of anomaly. Scoring for the first test was simple. Each accurate definition received a value of one point and each appropriate example received a value of one point. Participants could therefore miss up to six points on the first test. The second test required participants to create a set of normalized database relations. This test required application of normalization knowledge and measured task performance. On this test, each violation of a normalization rule resulted in a one-point deduction, and missing or inappropriate attributes resulted in a one-point deduction.<sup>5</sup>

Accounting GPA was included as a covariate in the statistical analyses to control for performance differences that result from individual differences in ability. Given that the design was a quasi-experiment, it was important to measure individual ability to insure that individual differences across class sections did not drive the results. Extensive research indicates that individual ability can influence performance, and GPA has been found to be one of the strongest predictors of success in accounting coursework (Hill 1998; Danko et al. 1992; Park and Kerr 1990; Borg et al.1989).

We also used the Individual Difference Questionnaire (IDQ) to measure individual differences that may be important in the present study (Paivio and Harshman 1983). As discussed earlier, the IDQ yields both a verbal score and an imagery score. The imagery score reveals the tendency to rely on images and non-verbal strategies for learning.

During the week following the administration of the knowledge and performance tests, we solicited students’ opinions of the normalization material to measure student satisfaction. Participants rated the following three statements on a scale of 1 (strongly disagree) to 5 (strongly agree):

1. I was satisfied with the material presented in the normalization module.
2. The instructor effectively delivered the material in the normalization module.
3. Overall, I am satisfied with the accounting information systems course.

**RESULTS**

Table 1 presents descriptive statistics of the number of errors made on the two normalization tests, aggregated by treatment condition. On both tests, participants who interacted with the database management system made fewer errors.

**Table 1**  
**Number of Errors on Normalization Tests by Treatment and Test Type**

<b>Treatments</b>	<b>Exam Type</b>	<b>N</b>	<b>Mean Errors</b>	<b>SD</b>
No Database Use	Anomaly <sup>a</sup>	34	2.62	1.30
	Normalization <sup>b</sup>	34	3.62	1.60
Database Use	Anomaly	32	1.69	1.31
	Normalization	32	2.06	1.77

<sup>a</sup> Subjects completed two different tests to measure learning of normalization concepts. The anomaly test was a direct test of knowledge of anomalies, where subjects were asked to define the three basic anomalies and create examples of each type.

<sup>b</sup> In the normalization test, subjects had to create a set of relations in third normal form. This test measures task performance.

Panel A of Table 2 presents the results of an ANCOVA model with the score on the knowledge test as the dependent variable.<sup>6</sup> The independent variables of interest are the treatment (i.e., use of the database technology or no use of the database technology) and the imagery score. A continuous covariate for GPA is also included in the model.

**Table 2**  
**ANCOVA Models for Scores on Normalization Tests**

**Panel A: Knowledge Test - Anomaly Definition**

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatment <sup>a</sup>	14.93	1	14.93	8.28	0.006
GPA <sup>b</sup>	0.06	1	0.06	0.03	0.854
Imagery Score <sup>c</sup>	0.45	1	0.45	0.25	0.621
Imagery* <i>Treatment</i>	0.06	1	0.06	0.03	0.856
Error	108.17	60	1.80		
Total		65			

R square = .122

**Panel B: Performance Test - Normalization**

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatment <sup>a</sup>	42.03	1	42.03	17.12	0.000
GPA <sup>b</sup>	0.01	1	0.01	0.01	0.944
Imagery Score <sup>c</sup>	0.53	1	0.53	0.21	0.645
Imagery* <i>Treatment</i>	0.08	1	0.08	0.03	0.854
Error	147.28	60	2.46		
Total		65			

R square = .240

<sup>a</sup> Half of the subjects interacted with a database management system during lecture, and half of the participants did not interact with the database.

<sup>b</sup> GPA is the subject’s accounting grade point average. GPA is included as a control for individual ability.

<sup>c</sup> The imagery score is from the Individual Difference Questionnaire, and it controls for participants’ preferences for imaginal processing.

In the knowledge acquisition model, the treatment variable is statistically significant ( $p < .006$ ), supporting the first hypothesis. Participants who interact with an Access database during class lectures learn more about normalization than participants who receive the same database material without using the database system. However, the results do not indicate that preference for imagery has an effect on the benefits of interacting with technology. There is also no significant interaction between the treatment and preference for imagery. Therefore, Hypothesis 3a is not supported.<sup>7</sup>

We also find that accounting GPA is not a statistically significant predictor of knowledge acquisition. The upside of these results is that participants of either learning preference (low versus high imagery) and all levels of prior accounting performance appear to benefit equally from the opportunity to work with the database management system during lecture. The results are not specific to students who perform well or poorly in other accounting courses.

Results of the performance test are presented in Panel B of Table 2. In this model, the score on the performance exam is the dependent variable. The independent variable of primary interest in the model is again the use or non-use of the database technology, and the same covariates for GPA and imagery score are included the model. Again, the treatment variable is statistically significant ( $p < .001$ ), providing support for the second hypothesis. Students who use an Access database during class lectures perform better on subsequent normalization tasks.

Apparently, experience with a sample database enhances students' *acquisition* of normalization knowledge and their *performance* on subsequent normalization tasks relative to traditional classroom lectures and lecture-based demonstrations of the same material. Similar to the knowledge model, GPA was not significant in the performance model. In addition, we found that the imagery score was not significantly related to performance, and thus, no support for Hypothesis 3b.

The final test examines the effects of database technology use on students' attitudes and satisfaction with the material and the instructor. Hypotheses 4a and 4b examined whether students who had experienced the hands-on exercise with the database material were more satisfied with the course material and the instructor delivering the material than the students in the lecture-only group who did not have the opportunity to use database technology during class. We used independent sample t-tests to compare the mean responses to each of the three questions that are identified at the end of the Experimental Design section.

The results indicate that students in the technology use treatment were more satisfied with the normalization material (mean response = 3.94), gave higher evaluations to the instructor (mean response = 4.75), and were more satisfied with the course (mean response = 4.30) than students who were in the lecture-only group (mean responses = 3.10, 4.32, and 4.04 respectively). These differences in satisfaction and instructor ratings are statistically significantly different ( $p < .05$  for all measures), and support hypotheses 4a and 4b.

## **CONCLUSIONS**

This study finds that technology can be effectively used in the classroom to enhance learning, performance, and student satisfaction through more active participation in the learning process. This is potentially an important finding because firms continue to adopt enterprise resource planning systems and technologies that integrate business information processing systems and data. Thus, database design and modeling proficiency are essential components of the new skill sets needed by accounting practitioners. The present study addresses teaching methods that have the potential to improve student development of critical database knowledge and skills.

Bryant and Hunton (2000) analyzed the behavioral and cognitive influences of instructional technology and developed guidelines for implementing technology in the classroom. Following these guidelines, we developed a method to employ technology to teach a very complex accounting information systems topic. Students who used an accounting database management system during class presentations on normalization acquired more database knowledge, performed better on subsequent normalization tasks, and were more satisfied with the course and instructor than students who did not interact with the database. This result parallels findings from the extant educational psychology literature that has found active engagement in the learning process facilitates learning (e.g., Bonwell and Eison 1991).

## **LIMITATIONS**

Our results must be considered in light of the limitations of the study. The design was a quasi-experiment, where each participant was not randomly assigned to the treatment condition. As a result, differences in class sections could influence the results. We measured and controlled for individual ability and preferences for imagery-based learning. While we detected no significant individual differences across sections and controlled for ability with GPA, there could be unmeasured variables that affect the results. In addition, the students were all located at one public university and therefore, may not be similar to students at other universities.

## **SUGGESTIONS FOR FUTURE RESEARCH**

Many interesting avenues of this research may be explored. For example, to replicate the results found in the present study, researchers could use different students in different parts of the United States. Also, other examples of database usage could be developed to establish the value of using technology to augment lectures in AIS courses. Our results suggest that AIS educators have an opportunity to improve students' knowledge of database systems and

performance on complex data modeling tasks through the introduction of readily available database technology into classroom instruction.

## ENDNOTES

<sup>1</sup> Declarative knowledge is often considered knowledge of facts, whereas procedural knowledge is knowing how complete a process or problem.

<sup>2</sup> Using Bloom et al.'s (1956) taxonomy, there are six levels of thinking (from lowest order to highest order): knowledge, comprehension, application, analysis, synthesis, and evaluation. Knowledge is recall of words, facts, dates, etc. A higher level, such as analysis, requires that an individual be able to identify the elements, relationships, and organizational principles of a situation.

<sup>3</sup> These guidelines are: 1) Students should be cognitively and physically engaged; 2) Students should know the objectives and be able to determine if they have met the objectives; 3) Feedback should be given; 4) Individual characteristics of the learner should be considered; 5) Tasks using educational technology should be organized from simple to complex; 6) Learners should progress at their own pace; and 7) Higher-order learning should be matched to higher-order technology, and lower order learning should be matched to lower-order technology.

<sup>4</sup> Shadish et al. (2002) define quasi-experiment as an experiment in which units are not assigned to conditions randomly.

<sup>5</sup> Alternative scoring methods, such as two-point deductions for normalization violations, produce the same results. The grader was unaware of the treatment groups for both tests.

<sup>6</sup> We conducted several analyses to check for violation of ANOVA assumptions. Levene's test of equality of error variances was not significant and indicated no problem with the equal variance assumption, analysis of standardized residual plots indicated no problems with the distribution of errors, and the Shapiro-Wilkes test for normality was also non-significant.

<sup>7</sup> We also analyzed the effects of verbal preference scores and all combinations of low versus high verbal and imagery scores on participants' performance on the two normalization tests. We found no significant results for any measures from the IDQ.

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**APPENDIX**

**Anomaly Examples for Lecture-Only Group and Hands-on Computer Group**

*Note: Students also received examples during lecture of anomalies that occur as a result of first and second normal form violations. These examples were the same for all subjects, and all subjects received these examples in lecture form.*

*Only the examples described below were presented in either lecture-only format or lecture plus hands-on interaction with the database. The only difference between treatments was the fact that database users actually attempted to insert, update, or delete using the examples provided in lecture. They were provided with a database that was designed based on the sample table below. The subjects did not have any other interactions with the database. The experiment administrator had control of all student terminals throughout the entire experiment.*

*Note: underlined attributes are primary keys and attributes in Italics are foreign keys. This was the standard method used in class.*

Consider the following relation. It is not in second normal form.

(Supplier#, Part#, Supplier Name, City, Part Description, Quantity on hand)

How can we fix this relationship?

(Supplier#, Supplier Name, City)

(Part #, Part Description, Quantity on hand)

(Supplier#, Part#, Quantity on hand by supplier)

**Failure to be in normal form causes anomalies. The primary types of anomalies are:**

**Insert anomaly:** you want to add an instance to a relation, but you can't.

Consider the table from the above example (before we fixed it). What happens if you want to add a new supplier (1007, Supplier XYZ, Phoenix)? Notice that you cannot add a supplier until you have a Part#.

**Delete anomaly:** when you delete one item from the relation, you lose something that you still need.

Again consider the supplier/part table from the example above. What happens when you delete Supplier #1002, which is the only supplier of Part#103? Recognize that when you delete a supplier, you could lose all of the data about a part.

**Update anomaly:** non-key data is repeated and updating the data is difficult or impossible.

In the above example, we carry a name, city, part description, and part quantity for every supplier. Now assume that we want to change the description of part#104. What will you have to do? (*Note: in the class example and database, 6 different suppliers all supplied part#104. So, the students have to change the description in 6 places*)

### **Handout to Both Groups of Students Logical Design and Normalization**

#### **Terms:**

Table is called a relation, Columns are attributes, Rows are tuples. Some basic rules for table creation:

- Every table has a unique name.
- Every row is unique.
- Attributes in tables have unique names.
- The order of the columns and rows is irrelevant.
- Each relation has a set of identifiers called keys.

**Primary key** – uniquely identifies a row (tuple)

**Foreign key** – attributes based on a primary key that are used to link relations

#### **Turning your ER diagrams into relational tables (Mapping Binary Relationships):**

- One-to-Many: Primary key on the one side becomes a foreign key on the many side.
- Many-to-Many: Create a new relation (associative entity) with the primary keys of the two entities as the primary key.
- One-to-One: Primary key on the mandatory side becomes a foreign key on the optional side.

How do we insure that we design tables that result in a reliable and efficient database? We use **Normalization** - a set of rules for taking relations and putting them in their simplest form. Normalization simplifies the database structure and eliminates anomalies (insert, update, and delete).

**Steps in Normalization:**

**(For each step, What is wrong with the table? How can we fix it?)**

- 1) **First Normal Form** – all non-key attributes are singular with respect to the key.  
(Employee#, Name, Dept, Salary History)  
Salary history includes: date, position, salary.
- 2) **Second Normal Form** – Must be in first normal form. All non-key attributes relate to the entire key. This is only important when there are multi-attribute keys.  
(Purchase#, item#, item description, qty on hand, date)  
Assume that each student has one major.
- 3) **Third Normal Form** – Must be in second normal form. All non-key attributes must be independent.  
(Customer#, Name, Address, City, State, Zip, Balance)

**Failure to be in normal form causes anomalies.**

**Insert anomaly** – you want to add a relation but can't. For example, in #2 above you cannot add a new item until you have a purchase#.

**Delete anomaly** – when you discard one item, you lose something that you still need (e.g., if you delete a purchase, you could lose the information about the item).

**Update anomaly** – non-key data is repeated and update is difficult or impossible. In example #3, we repeat the city and state information unnecessarily.