

CHAPTER 3 METHODOLOGY

An informal pilot study using ten participants was conducted during the fall of 1998 to assess and troubleshoot the WebPages used for the study. The directions and format of the pages were modified based on the outcomes from this pilot study.

Based on the aforementioned research, the hypotheses were formulated: (All hypotheses will be tested at $\alpha = .05$).

1. There is no significant difference in post-assessment scores between the constructivist and the objectivist presentation formats in an on-line learning environment.
2. There is no significant relationship between post-assessment scores and the participant's gender, age, or racial identity.
3. There is no relationship between the aptitudes of verbal comprehension and the post-assessment score.
4. There is no significant relationship between attitudes towards computers and post-assessment scores.
5. There is no significant relationship between self-regulated learners or self-efficacy and post-assessment scores.

Setting

This study was conducted using computers equipped with Internet access in various laboratories, homes and businesses on and around the University of Florida (UF) campus. To ensure equal access to all participants, the UF maintains several computer laboratories with adequate hardware configurations and software applications to support Internet connections to all UF students.

Participants

The participants for this study were one hundred and forty-five volunteer post-secondary students from the Engineering Research Center (ERC) and the College of Engineering at the University of Florida. They included 84 male and 61 female students of different ages with mixed cultural identity differences (see tables 3-1, 3-2 and 3-3).

Table 3 -1. Gender Distribution of Participants.

	Males	Females	Total Number
Constructivist Group	44	24	68
Objectivist Group	33	32	65
Control Group	7	5	12
Total Number	84	61	145

Table 3-2. Age Distribution of Participants.

Age (years)	Number of Participants
18-21	85
22-26	41
27-30	19

Table 3-3. Racial Identity Distribution of Participants.

Racial Identity	Total Number
White	111
African American	7

Native American	3
Hispanic	11
Asian Pacific	13

Data were collected during the final eight-week period in the fall semester, 1998. Upon logging on to the Internet, students were presented an information sheet describing the study, then asked to click on a submit button to acknowledge informed consent as per an Institution Review Board (IRB) requirement (Appendix A). Participants were randomly assigned to one of two treatment groups or a control (table 3-4). The design is a pre-assessment/post-assessment with a control group. The effect of the pre-assessment is not evaluated directly because this instrument influences all participants, but the data are used in the analysis of covariance to account for prior knowledge. The analyses are conducted on data collected from the 145 participants.

Table 3-4. Study Design.

Attitude, Verbal, and Self-Regulation/Efficacy	Group Assignment	Pre-Assessment	Treatment #1 Constructivism	Treatment #2 Objectivism	Post-Assessment
O	R (n=68)	O	X1		O
O	R (n=65)	O		X2	O
O	R (n=12)	O			O

All information was numerically coded by the participant's last four digits of their social security number, and confidentiality was maintained to the extent stated and required.

Independent Variables

The following characteristics of the students were used as independent variables for the study: gender, age, racial identity, attitude toward computers, self-regulated learning/self-efficacy and aptitude. Gender, age, racial identity, attitudes and self-regulated/self-efficacy were obtained through pre-study questionnaires and surveys. Aptitude information was obtained with a verbal comprehension test.

Gender, Age and Racial Identity

Gender is a true dichotomous independent variable with the sample of 145 participant's distributed as shown in Table 3-1. Age was measured on a continuous scale. Since post-secondary students are the target population, ages varied between 18 and 30 years old. Although 289 participants logged onto the webpage and 182 completed the study, 145 science and engineering participants below the age of 30 were selected for the study based on the completion of all forms and their major area of study. The distribution is shown in Table 3-5. Racial identity was measured as a categorical variable. Post-secondary engineering and science students are not equally divided, racially. The distribution of the 145 participants is shown in Table 3-6.

Table 3-5. Participant Continuous Age Distribution.

Age	18	19	20	21	22	23	24	25	26	27	28	29	30
#	6	21	29	28	17	9	5	10	1	8	3	6	3

Table 3-6. Racial Identity vs. Gender Distribution.

Racial Identity	White	African America	Native America	Hispanic	Asian Pacific	Total

		n	n			
Male	59	6	2	7	10	84
Female	52	1	1	4	3	61
Total	111	7	3	11	13	145

Attitude Towards Computers

Attitude was measured on an ordinal scale as an independent variable with a twenty-four item, 5-point Likert scale on-line computer attitude survey (Appendix B). The survey was administered to each participant prior to the completion of the instructional module. Results were analyzed using central tendency, reliability and standard error of measures. A pilot study was performed on this survey instrument to determine test reliability indices (Appendix C). Survey results included central tendency, reliability, standard error and item response theory measurements. The instrument produced the following results: internally consistency ($\alpha = .86$), reliability (split-half = .83; w/Spearman correction = .90) and was determined to be predictive of some attitudinal domains toward electronic information.

Self-Regulated Learning/Self-Efficacy

Self-regulated learning and self-efficacy was measure on an ordinal scale as an independent variable with an eighty-one item, 5-point Likert scale questionnaire called the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & Garcia, 1993). A sample that the participant would indicate whether it is true of them or not would be:

The most satisfying thing is to understand content thoroughly.

The MSLQ was administered prior to the completion of the instructional module. Previous results have shown that the MSLQ scale is to be a reliable and valid measure of self-regulated learning. The MSLQ is a self-report instrument designed to assess college student's motivational orientations and their use of different learning strategies and is based on a general cognitive view of motivation and learning strategies. There are 81 items, which takes approximately 20 minutes to complete.

Aptitude

A cognitive vocabulary test was used to determine verbal comprehensive scores. A sample of the verbal items provided for this study is:

Integrated

- 1 provender
- 2 connected
- 3 chorister
- 4 proscriptive
- 5 effulgence

Previous research has demonstrated that verbal comprehension is a good example of general aptitude. Scores ranged from 5-37 out of a 48 possible with a mean value of 21.

Pre-Assessment

In addition to a general chemistry section, all participants were provided a criterion referenced written pre-assessment (from the Engineering Research Center instructional manuals) (Appendix D). All questions were based on the concepts presented in the web-based instruction modules. Content validity was established by experienced judges in the area of science education, informal settings (museums and zoological parks), and an ERC education specialist. Split-half reliability was calculated using the Spearman-Brown formula. The pre- and post-assessments consist of two subsections. The initial subsection measures basic general chemistry knowledge and the second subsection focuses on the specific information which the module presents. There has

been prior research in the area of constructivism versus objectivism which has used only forced choice assessments (Thede, 1995). This research has generally shown results of significantly higher total and recall scores for the more structured, objectivist instruction. Chang (1994) also reported that students in the constructivist approach did not perform significantly higher than students in the conventional treatment on multiple-choice scores. For this study, a combination of both forced and free choice items were used for the assessments.

Experimental Design

The design is a modified pre-assessment/post-assessment with control group design. Both treatment and control groups were randomly assigned, and all were provided with pre- and post-assessments to assure equivalent groups. The only difference between each of the three groups is that Treatment #1 received a constructivist instructional module with multiple links; Treatment #2 received an objectivist module with a linear path and the control group did not receive an instruction module.

Instrumentation

The instruments used for this study include an on-line computer attitude survey, a Motivated Strategies for Learning Questionnaire (MSLQ); a verbal comprehension test; and pre- and post-assessments.

Instructional Materials

Constructivist Instruction Module

A complete copy of the constructivist instructional module is presented in Appendix E. A true constructivist environment in Cyberspace would allow the user to access all areas of the Internet. However, in this study, it is impractical. Therefore a constructivist environment has been operationally defined as one, which allows the participant to access several internal links to build their knowledge of the subject (see figure 3-1).

<u>THE NATURE OF THE PARTICLE SURFACE</u>			
<p>There are many physical and chemical measurements, which are descriptive of the nature of a particle system. The use of the term "particle system" implies the existence of a finely divided particle phase in a continuous phase. The particle phase is generally one of finely divided solids or liquids and the continuous phase is a liquid.</p> <p>What might be an organic example of this liquid phase?</p> <p>What physical measurements of particles could be useful?</p>			
Page 1 Answers	Particle Systems	<- Back	Forward ->

Figure 3-1. Constructivist Instructional Module Example WebPage Display.

Objectivist Instruction Module

A complete copy of the objectivist instructional module is presented in Appendix F. For this approach, material is presented in a prescribed linear order. The computer module allows the participant to examine the textual information for a duration of their choosing, however after the completion of a screen, they are presented with only one link which forwards to the subsequent page of text (see figure 3-2). The participant is allowed to move backward to a previous page to review previous topics.

<u>THE NATURE OF THE PARTICLE SURFACE</u>

There are many physical and chemical measurements, which are descriptive of the nature of a particle system. The use of the term “particle system” implies the existence of a finely divided particle phase in a continuous phase. The particle phase is generally one of finely divided solids or liquids and the continuous phase is a liquid such as water, an organic such as alcohol, or an oily liquid such as a hydrocarbon. Physical measurements of particles, e.g., density, porosity, linear size, shape, surface area, etc., are very useful. Such information can be used to understand and predict how to modify the particle system.



Figure 3-2. Objectivist Instructional Module Example WebPage Display.

Post-Assessment

A criterion referenced written post-assessment was provided following the instructional modules (from ERC instructional manuals) (Appendix G). All questions were based on the concepts presented in the web-based instruction modules. The post-assessment provided the exact same items as the pre-assessment.

Procedures

The participants were undergraduate and graduate students recruited from the Engineering Research Center (ERC) and the College of Engineering at the University of Florida. Participants were asked to read and submit an electronic IRB approval consent form. Following consent, the participant completed the following forms: a computer attitude survey; a Motivated Strategies for Learning Questionnaire (MSLQ) which determined the participant's self-regulated/self-efficacy abilities; and a verbal comprehension test to determine general aptitude. These forms were followed by a pre-assessment, then the instructional module and subsequent post-assessment. Each participant was randomly assigned to one of the two treatments or the control by drawing a number out of a hat with a web address in class or by selecting “1”, “2” or “3” on the Internet instructions. The number correlates to one of three web addresses: the constructivist instructional module, the objectivist module, or the control site. If the participant accessed the web page directly, they randomly selected one of the three pathways. Once they identified which computer system they would be using and logged on to the Internet, they typed the randomly drawn web address. The address is entered at the top of their Internet Browser where a display of [http://www..... .com/] is found. After entering the address, they press the enter key to signal the browser to locate the web site. The address selected transfers the participant’s Internet signal to the ERC homepage. At the bottom of this homepage, there is a “Learning Study” link provided. Once the study link was initiated, complete detailed instructions were downloaded (Appendix A). They were instructed to complete the forms entirely and individually on-line. After completing each form, they were to continue to the subsequent form using the “FORWARD” link. When they were complete with the final post-assessment, they were asked to submit their responses to complete the study.

Data Analysis

An analysis of covariance (ANCOVA) was used to determine the format/participant relationships among the dependent variable, the achievement on each of the formats and the independent variables, gender, racial identity, verbal aptitudes, attitudes, and self-regulated learning/self-efficacy. Scores on the post-assessment were not significantly different between each type of instructional format for web-based learning. Likewise, gender and age did not affect the post-assessment scores. It was not possible to determine differences in racial identity due to the low number of participants. However, it was observed that the older the participant, the better they performed after completing the objectivist instructional module. Attitudes toward the computer, verbal aptitudes and self-regulated/self-efficacy learning did not affect post-assessment scores significantly.