Comparisons of Group-based and Individual-based Assignments in an Engineering Graphics Course within a Higher Education Learning Environment

David W. Melton  
School of Industrial Technology  
Eastern Illinois University, Charleston, IL 61920

Kurt H. Becker  
Engineering and Technology Education  
Utah State University, Logan, UT 84322

ABSTRACT - This paper presents findings of a study that looked at two questions: (1) is student knowledge and skills in engineering graphics significantly improve when group-based activities are used compared to individual-based activities; and (2) do students prefer group-based over individual-based activities. This study focused on the effects of learning through group-based activities based on three variables: knowledge, skills, and attitudes. A quasi-experimental pretest-posttest, nonequivalent-control group design was used during the study. Data collection and analysis was based on quantitative and qualitative feedback derived during the participants’ testing/survey sessions. The results provided insight in curriculum development of a computer-aided design course.

I. Introduction

Educational researchers continually evaluate the effects of different teaching methodologies. One of those methodologies, group-based learning, has been evaluated over the past few decades to identify the effects and significant roles it has on student learning compared to individual-based or traditional learning (Springer, Stanne, and Donovan 1999).

Some studies pertaining to instruction in the areas of science, math, engineering and technology (SMET) education have shown positive outcomes with group-based learning and activity (Springer et al., 1999, Sungar and Tekkaya, 2006). Galand, Bentien, Bourgeois, and Frenay (2003) found that students participating in small group-based learning activities have developed elaborate skills in strategies, critical thinking, metacognitive, self-regulation, effort regulation, and peer learning.

Other studies have questioned those findings regarding group-based learning activities. Findings have indicated that group-based learning may not be the best method of teaching and learning (Albanese and Mitchell, 1993, Vernon and Blake, 1993) for those courses designated as introductory (Miller, and Cheetham, 1990). Studies have shown that students receiving traditional learning methods perform better on assessment of knowledge and skills.

Limited research with group-based learning compared to individual-based learning has been conducted in engineering and technology education. Studies based on engineering computer-aided design and drafting and the effectiveness of group-based activities in developing student knowledge, skills, and student preferences has not been addressed in the literature.

II. Purpose and Objectives

This research analyzed the effects of group-based and individual-based activities pertaining to knowledge gained and retained, skills developed, and students’ attitudes relative to these different learning experiences. Specifically, a quasi-experimental study was conducted
to: 1) determined if student skills and knowledge in engineering graphics significantly improved when group-based activities were used compared to individual-based activities; 2) identify whether students preferred group-based activities to individual-based activities.

To complete this purpose the following objectives were established:

1. Determine statistical significance of knowledge gained and retained through group-based activities compared to individual-based activities in an engineering graphics course.

2. Determine statistical significance of skills developed through group-based activities compared to individual-based activities in an engineering graphics course.

3. Identify whether the students in an engineering graphics course preferred group-based activities to individual-based activities.

**Research Question One (Cognitive Construct).** Is there a significant difference of knowledge gained and retained in an engineering graphics course when students complete group-based activities compared to individual-based activities as measured through a series of achievement tests? In this study, the criterion for statistical significance was the accepted $p < 0.05$.

**Research Question Two (Functional Construct).** Is there a significant difference in skills developed in an engineering graphics course when students complete group-based activities compared to individual-based activities as measured through a series of skills test?

**Research Question Three (Motivational Construct).** Is there a significant difference in attitude towards an engineering graphics course when students complete a group-based learning module compared to an individual-based learning module as measured by the use of the Activity Environment Survey (AES)?

### III. Methodology

**Setting and Subject Description.** The study utilized two sections of the undergraduate computer engineering drafting course, taught at Utah State University (USU) in Logan, Utah. The instructor during the study was the researcher, who taught the course for two years prior to the research study. Both group-based and individual-based activities were piloted by the researcher prior to this study.

Students enrolled in the course were from the College of Engineering - Departments of Biological and Irrigation Engineering, and Civil and Environmental Engineering. Open enrollment at the university provides students from all majors the opportunity to enroll in this introductory engineering graphics course.

The sample consisted of 76 students from Utah State University. There were 36 students in Group 1 and 40 in Group 2. Sixty-three (82.9%) of the students were male and thirteen (17.1%) of the students were female.

**Independent Variables.** Two independent variables were used during this study. The independent variable was presented with two levels: group-based and individual-based learning methodologies. The difference between the two methods was in the execution of the group-based and individual-based learning activities.

<table>
<thead>
<tr>
<th>Table 1. Procedures for Administering Knowledge Tests.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Subgroups</strong></td>
</tr>
<tr>
<td>Test B</td>
</tr>
<tr>
<td>Test C</td>
</tr>
</tbody>
</table>
Group-based activities were provided to small groups upon completion of a lecture, demonstration, and Q&A session. The activities were based on the material discussed during the lecture. The group-based activities were a reflection of real world working scenarios in an engineering graphics setting. The activities introduced a problem to the small group. The group members analyzed the problem, determined potential solutions, analyzed the possibilities to find the best solution, and then resolved the problem.

Individual-based activities were provided through the course textbook upon completion of a lecture, demonstration, and Q&A session. The activities were based on the material discussed during the lecture. These activities were completed by the individual students and reflected their individual knowledge and understanding of the discussed material.

Dependent Variables. The three dependent variables included knowledge, skills, and attitudes in regards to each learning module. Student’s knowledge and skills were based on the instruction and activity phases of the learning module. Student’s attitudes were based on the individual perceptions relating to the type of activities they experienced during the study.

Instrumentation. Knowledge Test. A pretest-posttest-delayed posttest design was used to collect data to determine student knowledge gained and retained. Data was collected from the pretest administered before each learning module.

The posttest was administrated directly after each learning module; the delayed posttest was given two weeks following the completion of the learning module.

Each learning module had a pretest, posttest, and delayed posttest. Each of the tests consisted of questions that pertained to the objectives of the particular learning module. The tests were administered as shown in Table 1.

Each test was given to 1/3 of the students during the pretest, posttest, and delayed posttest. Each knowledge test consisted of three separate tests designated as Test A, Test B, and Test C (see Fig 1). No student was given the same test more than once. Each test had a maximum score of 25 points and included 25 questions (multiple choice, true/false, and fill in the blank).

Skills Test. Three skills test were administered during the course. Each test accessed basic skills relating to drawings, views, and dimensioning. These tests were identified as Preskills Test, Skills Test 1, and Skills Test 2. Analysis was performed on both the scores of the individual student, and both sections of the learning module.

The Preskills test was given before the first module was introduced. Skills Test 1 followed the completion of Learning Module 1. With the completion of the Learning Module 2, Skill Test 2 was administered.

![Figure 1. Knowledge Test Sequence.](image-url)
Attitude Instrument (AES). The attitude data was collected from information obtained through the Activity Environment Survey (AES). The AES was provided to each student at the completion of the last module. The AES determined students’ perception of group-based activities compared to individual-based activities.

The AES was developed based on previously validated surveys. Those surveys are identified as: (a) Utah State University Teacher/Course Evaluation, (b) research report by Maunsaiyat (2002). The AES consisted of a non subject-specific survey of 14 items on a five-point Likert questionnaire and three open-ended questions that identify student’s perception and attitude regarding group and individual based activities.

The questionnaire portion of the survey had five possible answers: (a) “almost always”, (b) “often”, (c) “sometimes”, (d) “seldom”, and (e) “almost never”. The mean scores were used to determine the perceived attitude of the students with regard to group-based activities.

Design. A quasi-experimental pretest-posttest, nonequivalent control group design was used during the study. This design is a popular approach to quasi-experiments (Creswell, 2003, p. 169). Due to the registration process, true randomization of the sample was not available in this study. Gall, Gall and Borg (2002) stated the following about quasi-experimental: “This type of experiment, if carefully designed, yields useful knowledge” (p. 402).

Huck, Cormier, and Bounds (1974) stated that quasi-experimental designs need to “control one or two of the following: when the observations are made, when the independent variable is applied, or which intact group receives the treatment” (p. 301).

To eliminate validity concerns regarding random selection and bias towards a particular section, the study was broken into two modules of instruction. Students participated in both a control and treatment group. Both the control and treatment groups received a pretest, posttest, and delayed posttest. The study employed the “most commonly used quasi-experimental design in educational research … non-equivalent control-group design” (Gall et al., 2002, p. 402).

Additionally, the study utilized a counterbalanced design. “In a counterbalance experiment, each participant is administered several treatments, but the order of administering the treatments is varied across participants” (Gall et al., 2002, p. 415). This design allows the researcher to extract information from each student.

Table 2, represents the attributes of the design that were used during the study. The M represents a series of measures for the first learning module: M1 represents the pretest, M2 represents the posttest, and M3 represents the delayed posttest.

For the second learning module: M4 represents the pretest, M5 represents the posttest, and M6 represents the delayed posttest. Other symbols are defined as follows: X represents a series of interventions, “c” represents the control group, and “t” represents the treatment group. A numerical designation represents the instruction discussed (learning module).

Due the nature of the counterbalance design, each participant was administered a treatment during different times. Xt1 was applied during weeks 03 thru 05, and Xt2 given during weeks 11 thru 13. The order of receiving the treatment varied between the sections of the course to eliminate the possible confounding-of-order effect with treatment effects.
<table>
<thead>
<tr>
<th>Group</th>
<th>Pre1</th>
<th>Inst1</th>
<th>Post1</th>
<th>DPost1</th>
<th>Pre2</th>
<th>Inst2</th>
<th>Post2</th>
<th>DPost2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(1B, 2A)</td>
<td>M1</td>
<td>Xc1</td>
<td>M2</td>
<td>M3</td>
<td>M4</td>
<td>Xc2</td>
<td>M5</td>
<td>M6</td>
</tr>
<tr>
<td>2(1A, 2B)</td>
<td>M1</td>
<td>Xc1</td>
<td>M2</td>
<td>M3</td>
<td>M4</td>
<td>Xc2</td>
<td>M5</td>
<td>M6</td>
</tr>
</tbody>
</table>

**Note:**

Intervention 1 (t1) occurred during weeks 03 thru 05 (3 weeks) - Basic 2-D design
Intervention 2 (t2) occurred during weeks 11 thru 13 (3 weeks) - Basic 3-D design

Legend:

"M" represents a series of measures; "X" represents a series of interventions; "c" represents the control group; and "t" represents the treatment group. A numerical designation represents the topic or instruction discussed (learning module).

M1 and M4 are pretest; M2 and M5 are posttest; M3 and M6 are delayed posttest.

(Becker & Maunsaiyat, 2004)

**Data Analysis.** This research looked at three key measurements. One measurement analyzed students’ knowledge of engineering graphics. The second measure looked at students’ drafting skills. The third measure evaluated students’ perception. Each measure compared group-based activities to individual-based activities.

Effect size (ES), one-way ANOVA (analysis of variance), and repeated measures ANOVA statistical testing were performed to evaluate knowledge and skills measurements.

Cronbach’s alpha was selected in evaluating internal consistency of the research testing instruments. Cronbach’s alpha is not a statistical test, but is a method of finding the coefficient of reliability (or consistency) of a given test. Cronbach’s alpha scores of .70 or higher are considered acceptable results that reflect internal reliability in a given test instrument.

Before each learning module, students were provided a pretest to evaluate their knowledge of the learning module material. With the completion of the learning module, a posttest was given to evaluate knowledge and skills gained. Two weeks later a delayed posttest was provided to evaluate knowledge retained.

The AES was given after all learning modules were completed. The data measured the students’ perceptions regarding the two learning strategies.

**Instruction.** Two learning modules were used during the study. The first learning module was based on engineering geometry, multiview and auxiliary views, and dimensioning. The second learning module introduced the concept of 3-D modeling or pictorial drawings with respect to multiview, auxiliary view, and dimensioning. Course instruction consisted of lectures, demonstrations, Q&A sessions and lab activities. The lectures for both sections utilized the same textbook, handouts, instructor, and instruction.

Module #1 took place during weeks 3 through 5 of the semester. The treatment group participated in the group-based activities and students in the control group participated in the individual-based activities. The instruction for the control and treatment group met the objectives of the learning module. The module was taught to both the control and treatment group.

Module #2 took place during weeks 11 through 13 of the semester. The treatment group from Module #1
became the control group and the control group of Module #1 became the treatment group. Students in the treatment group participated in a group-based activities and the students in the control group participated in the individual-based activities. Instruction for the control and treatment group met the objectives of the learning module.

Learning module #2 was based on three-dimensional (3-D) pictorial design relative to multiview drawings and design. This module was taught to both the control and treatment group. Course instruction consisted of lectures, demonstrations, Q&A sessions and lab activities. The lectures for both sections utilized the same textbook, handouts, instructor, and instruction. Each section was taught in the same computer lab designed for the dissemination of information pertaining to the introduction of CADD.

**Pretest.** The pretest consisted of a 25-item assessment that accessed the student’s knowledge of the subject before the learning module took place. The pretest was provided to each section. The test evaluated knowledge and understanding of specific drawing and drafting concepts.

**Control Group Activity.** The control group received activities from the textbook that corresponded with the instruction provided during the learning module. The activities were individually assigned and completed by each student in the control group on the computer with the use of AutoCAD.

**Treatment Group Activity.** The treatment group was divided into 12 small subgroups. Each subgroup received an activity that they worked on cooperatively. The learning module consisted of discussions pertaining to multiple topics. Members of the subgroup were responsible for completing their portion of the activity. Group members were encouraged to work with other members of the group in the completion of the activity.

**Posttest.** The posttest consisted of a 25-item assessment on knowledge gained during the learning module. The posttest was administered to both the control and treatment groups. The test evaluated the knowledge gained on specific drawing and drafting concepts. The posttest was given to each student at the completion of the learning module.

**Skills Test.** With the completion of the learning module and the posttest, the next step was to administer the skills test. The test was based on AutoCAD skills taught during the learning module. The test was timed for both the treatment and control groups. Each group was provided the same test while using the same laboratory to perform the requirements of the test.

**Delayed Posttest.** The delayed posttest consisted of a 25-item assessment on knowledge retained two weeks after the learning module was completed. The delayed posttest was provided to both the control and treatment groups. The test evaluated the knowledge retained on specific drafting concepts. The delayed posttest was given to each student two weeks after the learning module was completed.

**Attitude Survey.** The Activity Environmental Survey (AES) consisted of 14 items on a five-point Likert questionnaire and 3 open-ended questions that identified each student’s perception of the learning method that took place during the intervention. The AES was administered after the completion of the learning modules.

**IV. Summary and Discussion**

This section addresses the research questions asked in the study. The idea of the study was to analyze the effects of group-based and individual-based
activities pertaining to knowledge gained and retained, skills developed, and students’ attitudes relative to these different learning experiences by using either statistical or practical significance in support of the findings. The following are the findings for each particular research question with a summarization and discussion.

Summary Relevant to Research Question One. Research question one evaluated students’ knowledge gained and retained based on a practical learning module that used group activities compared to a more traditional learning approach based on individual activities. Mean scores and statistical ANOVA testing (one-way and repeated measures) was used to test the null hypothesis.

As indicated in Table 3, mean scores of the pretests, posttests, and delayed posttest administered during the study, show no statistical significant difference between the mean scores of students receiving the group-based activities and those students receiving individual-based activities.

Learning Module 1 (Basic Two-Dimensional Drafting) provided minimal change between the posttest and delayed posttest of the group-based activities in comparison to individual-based activities. Change between the tests and groups were less than +/- .03%. Additionally, students who participated in the group-based activities actually increased the group’s mean score between the posttest and the delayed posttest. The individual-based activity group decreased their mean score.

As for Learning Module 2 (Three-Dimensional Drafting), analysis of the data indicated little change between the posttest results of the two learning activities and reflected no statistical significant difference. The delayed posttest results did indicate statistical significance between the control and treatment groups in that the individual-based group performed significantly better.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Learning Module #1</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group (N = 35)</td>
<td>Individual (N = 36)</td>
</tr>
<tr>
<td>Pre #1</td>
<td>14.49 (3.08)</td>
<td>13.56 (3.15)</td>
</tr>
<tr>
<td>Post #1</td>
<td>18.54 (2.43)</td>
<td>19.25 (2.86)</td>
</tr>
<tr>
<td>Delayed Post #1</td>
<td>18.86 (2.48)</td>
<td>18.42 (2.86)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tests</th>
<th>Learning Module #2</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group (N = 36)</td>
<td>Individual (N = 35)</td>
</tr>
<tr>
<td>Pre #1</td>
<td>13.20 (2.72)</td>
<td>12.72 (3.31)</td>
</tr>
<tr>
<td>Post #1</td>
<td>15.77 (2.57)</td>
<td>15.33 (2.14)</td>
</tr>
<tr>
<td>Delayed Post #1</td>
<td>16.71 (2.18)</td>
<td>15.11 (3.16)</td>
</tr>
</tbody>
</table>

Note. Standard deviations are in parentheses. Diff = Difference between means. ES (effect size) is indicated by Diff.
Possible reasons for Module 2 delayed posttest results were: 1) Influence by outliers that skewed the results, 2) The students were either better prepared or had a clearer understanding of the drafting assignments in the individual-based group, 3) Some of the group-based activities were more difficult and took additional time to understand and complete, 4) The individual-based students who participated in Module 2 performed better and achieved higher mean scores as members of the group-based activity group in Module 1. This indicated that they might have a better understanding of the material between groups.

In Learning Module 1 (Basic Two-Dimensional Drafting), the average mean score differences (group-based and individual-based learning groups) between the pretest and posttest are 4.9 (19.5%). This increase can be attributed to the ease of learning and teaching the topic, basic two-dimensional drafting. Two-dimensional drafting is based on the idea of drawing lines and arcs in the visualizing of simple parts and models. Completing given assignments is easy and allows students to gain a greater understanding of the material to be learned.

However, when both groups changed from either group-based to individual-based learning or from individual-based to group-based learning in Learning Module 2 the mean score differences between pretest and posttest averaged was 2.59 (10.3%). This limited increase of knowledge may be a result based on the difficulty of learning three-dimensional drafting. The abundance of information provided to the student during the learning module in addition to completing assignments can be overwhelming. Students often have a difficult time visualizing and comprehending 3-D models. The time spent in completing the assignments often leads to reduction of opportunity in learning the concepts of 3-D modeling.

In summarizing research question one, the following was concluded regarding statistical significance relative to knowledge gained and retained based on learning activities:

1. There was no statistical significant difference in the student mean scores on the posttest regardless of which type of assignment was given in either Module 1 or Module 2. All posttest mean scores of students receiving individual-based assignments were higher than those students receiving group-based assignments.

2. There was no statistical significant difference in the student mean scores on the delayed posttest for Module 1. Delayed posttest mean scores of the students receiving group-based assignments were higher than those students receiving individual-based assignments.

3. There was a statistical significant difference in the student mean scores on the delayed posttest for Module 2. Delayed posttest mean scores of the students receiving group-based assignments were significantly lower than those students receiving individual-based assignments.

Based on the analysis performed, knowledge gained and retained during the different learning modules, neither group-based activities nor individual-based activities had a statistical significant role in increasing the knowledge obtained by the students.

**Summary Relevant to Research Question Two.**

Research question two evaluated students’ skills developed as a result of a practical learning activity through the use of either group activities compared to a more traditional learning approach based on individual-based activities.

The null hypothesis for this research question should indicate that there are no statistical significant skills developed between students who participate in group-based activities compared to those who participate in individual-based activities.
Table 4. Descriptive Statistics for Skills Test.

<table>
<thead>
<tr>
<th>Skills</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean scores @ preskills test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>54.74</td>
<td>28.28</td>
<td>35</td>
</tr>
<tr>
<td>Group 2</td>
<td>64.67</td>
<td>24.53</td>
<td>36</td>
</tr>
<tr>
<td>Mean scores @ skills test 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment group (Group 1)</td>
<td>90.99</td>
<td>7.33</td>
<td>35</td>
</tr>
<tr>
<td>Control group (Group 2)</td>
<td>89.39</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>Mean scores @ skills test 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment group (Group 2)</td>
<td>88.44</td>
<td>6.45</td>
<td>36</td>
</tr>
<tr>
<td>Control group (Group 1)</td>
<td>91.17</td>
<td>13.45</td>
<td>35</td>
</tr>
</tbody>
</table>

Research question two evaluate student’s skills based on the data analysis results from students’ mean scores of the Preskills Test, Skills Test 1, and developed through the use of mean scores and statistical one-way ANOVA testing.

Skills Test 2 administered during the study proved no indication of a statistical significant difference between the mean scores of students receiving the group-based activities and those students receiving individual-based activities (see Table 4).

In comparing and analyzing the data, Skills Test 1 and Skills Test 2 had little difference in regards to the effectiveness that occurred during the learning activity. Both groups had substantial increase in student mean scores from the Preskills Test to Skills Test 1, but there was little difference between Skills Test 1 and Skills Test 2. The difference between the group mean scores pertaining to Skills Test 1 and Skills Test 2 was less than +/- .01%. It can be determined that neither learning activity had a significant impact on the development of skills in regards to the specific drafting principles and techniques.

In summarizing research question two, the following was concluded regarding statistical significance relative to skills developed in regards to learning activities:

1. Students in Group 2 achieved higher mean scores than Group 1 for the Preskills Test.
2. Following Module 1, Group 1 (Treatment Group) achieved higher mean scores than Group 2 (Control Group).
3. Following Module 2, Group 1 (now the Control Group) continued to have higher mean scores than Group 2 (Treatment Group).
4. Group 1 mean scores increased between Skills Test 1 and Skills Test 2. Group 2 mean scores decreased between Skills Test 1 and Skills Test 2.

Based on the analysis performed, skills developed during the different learning modules, neither group-based nor individual-based activities played a statistical significant role in increasing the development of skills obtained by students (see Table 5).

Summary Relevant to Research Question Three. Research question three evaluated students’ perceptions of what they thought was the best practical learning activity: group or individual activities.

The null hypothesis for this research question should indicate that there is no practical significance based on students’ perception of which learning method is better. Research question three evaluates student’s perception using mean scores, standard deviation, and percentages scores.
There was no statistical or practical significant difference found in students’ perceptions regarding a preferred method related to completing activities. Comments given by students in regards to experiences of the group-based activities included:

- enjoy doing group projects that reflect real world situation,
- group projects decreases the pressures of completing a large project on their own,
- opportunity to work and discuss with the group in understanding the project, design, and techniques (CAD) needed to complete the activities,
- group members personal schedules differ causing problems with interaction during the project without some flexibility of the group, because of work, classes, and other events.

The only meaningful or significant results found in the perceptions of the students about group-based and individual-based activities was regarding the effect that being a member of a group has on their careers.

Students stated that they understood the importance of interacting within the group because this will typically be the mode of the working environment they will see in their future.

### V. Conclusions and Implications

Based on the research and findings presented here, the following should be considered when contemplating the implementation of group-based learning activities into a CADD learning curriculum.

Introductory engineering courses introduce students to the building blocks of engineering that will eventually lead to the theoretical and advanced courses required to become professional engineers. Often computer-aided design and drafting (CADD) is considered one of those courses. Group-based activities are not the traditional teaching method that would be used for an introductory course.

Topics such as CADD, that have the function of building a foundation for further learning, can remain independent from group-based learning activities. Statistical and practical data from this research indicates that an introductory engineering course, such as CADD, can be taught just as effectively with a traditional learning methodology. With individual-based assignments, students can actually form the foundation needed to prepare them for more advanced coursework.

#### Table 5. One-Way ANOVA Summary Table for Skills Test.

<table>
<thead>
<tr>
<th>Tests</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preskills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>436.93</td>
<td>1</td>
<td>436.93</td>
<td>2.5</td>
<td>0.118</td>
<td>0.035</td>
</tr>
<tr>
<td>Within</td>
<td>12064.17</td>
<td>69</td>
<td>174.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12501.1</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills one</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>45.25</td>
<td>1</td>
<td>45.25</td>
<td>1.01</td>
<td>0.318</td>
<td>0.014</td>
</tr>
<tr>
<td>Within</td>
<td>3089.74</td>
<td>69</td>
<td>44.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3134.99</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills two</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>131.97</td>
<td>1</td>
<td>131.97</td>
<td>1.2</td>
<td>0.278</td>
<td>0.017</td>
</tr>
<tr>
<td>Within</td>
<td>7606.31</td>
<td>69</td>
<td>110.24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7738.28</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The traditional learning environment in a CADD drafting class allows students to freely interact and learn from each other as much, if not more so than from the instructor. It is possible that the way drafting courses are traditionally taught already uses many of the advantages found in group-based learning. The drafting learning environment is very different from many other subjects.

Can a course such as Introduction to Computer Engineering Drafting, which has been traditionally taught by using the scaffolding teaching strategy, be used for group-based activities? It can be a group-based learning experience, because Vygotsky implies that the scaffolding instruction role of teachers and others needs to support the learner’s development by providing structures to support the student in reaching the next level of learning (Raymond, 2000). CADD is a course in which one level of instruction is taught, and once understood, a second level or scaffold is added to the previous knowledge base.

Finally, it can be concluded that group-based and individual-based activities in a CADD course are of equal importance in developing a cognitive, functional, and motivational understanding of the basic objectives of a computer engineering drafting and design course.

This study found that there is no statistical significant difference in knowledge gained and retained (research question one), and skills developed (research question two) relative to the effectiveness of group-based activities compared to individual-based activities.

VI. Reference


