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The Study of Mastery Testing Strategy Versus an Averaging Testing Strategy

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THE STUDY OF MASTERY TESTING STRATEGY VERSUS AN AVERAGING TESTING STRATEGY

By

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Introduction - Mastery Learning:

Many critics of today's educational system have used adjectives such as wasteful and destructive to describe the present day system. In a society where an individual's chance for economic survival and security in the world of work is linked with his school learning success, schools provide successful and rewarding learning experiences for only one-third of our learners (Block, 1971). Assuming this is accurate, most students are likely to acquire neither the basic skills nor the interests and attitudes required obtaining and/or maintaining a job with a advanced standard of living. We can no longer afford for students to continue for ten to twelve years under conditions that are repeatedly frustrating and humiliating (Block, 1971). We must therefore provide for the majority of students, the opportunity to acquire the skills and knowledge necessary to succeed (Bloom, 1971). Yet it is important to realize that for the largest proportion of the workforce, continued learning is essential. Lack of success in an educational setting, ultimately reduces a student's desire for further learning. Only continual success and reward will induce desire in a student so that learning will continue. Therefore the question becomes, how can we adapt or change conventional methods so those students that are not being served by today's educational methods can join those that are and therefore all students can learn?

Benjamin Bloom proposed a philosophy, a model for mastery learning in which the basic premise asserts that all or almost all students can master what they are taught given appropriate instructional conditions (Block, 1975). The idea of learning for mastery is an old concept. Two major attempts were made in the 1920's to establish mastery in student learning. Carleton Washburne and his associates (1922) and Professor Henry C. Morrison (1926) both produced models that laid a solid foundation for mastery learning (Block, 1975).

Both early versions of mastery learning shared many major features. These include identifying the educational objective that each student was expected to achieve, well defined learning units, complete mastery of each unit before proceeding to the next, diagnostic-progress-tests to provide feedback and correctives to supplement the original instruction (Block, 1975). Yet the idea of mastery learning disappeared and did not resurface until the late 1950's, early 1960's.

Programmed instruction provided the necessary pathway back to mastery learning. The basic idea of programmed instruction was that the learning of any behavior, no matter how complex, could be attained by breaking down the behavior into less complex sequences. By mastering each sequence of the chain, any student could master the most complex skill. Programmed instruction was effective for only a few students and ineffective for most (Block, 1975).

"In each task the student proceeded from ignorance of some specified fact or concept to knowledge or understanding of it… from incapability of performing some act to capability of performing it", states John B. Carroll (Block, 1975). It is Carroll's Model of School Learning that Bloom transformed into an effective working model for mastery learning (Block, 1975). Carroll's conceptual model identifies what major factors influence a student's success in school learning and how these factors interact. He derived his model from an observation linking student's aptitude for a particular subject, predicting either the level at which a student could learn the subject in a given time or the time required to learn it at a given level. Aptitude, as defined by Carroll, is a measure of the learning rate or the measure of the amount of time a student is required to learn a subject at a given level under ideal instructional conditions (Block, 1975; Bloom, 1971; Hymel, 1993). If a student was given the necessary amount of time needed to attain a criterion level, and the student spent this amount of time, he would reach mastery of the subject studied. Carroll identified a function, the degree of school learning as follows:

$$\text{Degree of School Learning (DOSL)} = f\frac{(\text{time spent})}{(\text{time needed})}$$

(Block, 1975; Hymel, 1993)

The DOSL depends on the time the student actually spent learning relative to the time he needed to spend. Carroll believed that the time spent and time needed were influenced not only by characteristic qualities of the learner but also by characteristic qualities of instruction. Time spent could be determined by either the amount of time the student was willing to devote to actively participate in learning, the student's ***perseverance***, or, the class time allotted for learning, ***opportunity to learn***. Time needed was dependent on the student's ***aptitude*** for the subject, the ***quality of instruction*** and his ***ability to understand this instruction***. Substituting these qualities into the function allows us to define DOSL as follows:

$$\text{DOSL} = f\frac{(\text{1. perseverance, 2. opportunity to learn})}{(\text{3. aptitude, 4. quality of instruction, 5. ability to understand instruction})}$$

Therefore, the DOSL of a given subject depends on the students 1)perseverance, or 2)opportunity to learn relative to his 3)aptitude for the subject, 4)quality of instruction and 5)ability to understand instruction. (Block, 1975; Bloom, 1971)

Bloom argued, if aptitude was predictive of the rate of learning, not necessarily the level of learning, then it should be possible to set a criterion level expected that all students could master (Block, 1975). Bloom's work stemmed initially from individual differences. He wanted to provide teachers with strategies that would allow their students to learn effectively whatever they taught. By altering teaching and learning process, individual differences were easily accommodated and more students could obtain very high levels of achievement. Traditionally, achievement measurements were designed so that grades could be assigned based on trivial individual differences among the learners (Bloom, 1971). This was usually done according to a normal distribution where rank of position determined students failure. "We teach as though only a minority of our students are able to learn", Bloom argued (Bloom, 1971). Instead, the achievement distribution should be vastly different from a normal distribution. If instruction is effective then the distribution should be negatively skewed (Bloom, 1971). If all students received uniform instruction then the relationship between aptitude and achievement was high. Providing uniform opportunity to learn, uniform quality of instruction few students will attain mastery. But if there was optimal instruction for each student there was no relationship and the majority of students could be expected to attain mastery.

Optimistic theoretical assumptions of mastery learning argue that under favorable conditions the following expectations are viable:

a. most students can master what we have to teach them
b. as many as 80% of our students can attain high levels of achievement typically reached by only the top 20% of students
c. most students become very similar, rather than dissimilar with respect to learning ability, rate of learning, and motivation for further learning as they progress more deeply into a given course of study
d. profound advancements in student performance occur not only in the domain of cognitive learning but also in student attitudes, interest, self-concept and mental health

(Hymel, 1993)

The mastery learning strategy involves the following:

a. concepts and materials are organized into instructional units
b. following a quiz or assessment, feedback is administered
c. a formative assessment identifies what students have learned well and what they need to learn better including suggestives to correct errors identified (correctives are "individualized")
d. when student completes corrective activities, they are administered a second formative assessment to verify whether correctives were successful, this offers students a second chance at success serving as a powerful motivational device
e. enrichment or extension were given to students who attained mastery from initial teaching, this provided a means for students in challenging, high level activities designed for gifted and talented students.

(Guskey, 1994)

(See Appendix – Figure A1: The Mastery Learning Instructional Process)

Data indicates mastery methods drastically cut the number of students who receive C/D or F scores. There is a growing body of evidence that mastery learning can yield better retention of selected topics than non-mastery methods (Block, 1975). Also mastery methods yield greater student interest. Students exhibit greater positive attitudes toward subjects, and an increased confidence regarding their ability to learn (Block, 1975). Mastery learning is helping students learn to learn. They become more exposed to other teaching methods in addition to lectures and textbooks. There is more cooperation towards their own learning, they are more careful and selective, and gain some measure of control over study habits and spend much more time actively engaged in the learning process (Block, 1975).

Bloom believed all students could be provided with a more appropriate quality of instruction. And under more favorable learning conditions, providing the necessary time and appropriate learning conditions (Guskey, 1992), nearly all students could learn excellently and truly master the subject material (Guskey, 1994). It is a combination of a thoughtful curriculum and effective instructional practices that makes true improvement in education possible (Guskey, 1994).

Introduction - Gender Difference in Learning Styles:

Traditional teaching techniques involve lecture and individual seat work. These methods are believed to encourage the learning styles of male students. According to Schwartz and Hanson, male students learn through "argument and individual activities" (Lackey, 1995). Female students on the other hand learn better through a "conversational style that fosters group consensus and builds ideas on top of each other" (Lackey, 1995). Traditionally male students learn better through individualism and competition. Male students prefer to work independently rather than in group situations (Lackey, 1995). Therefore we must ask is it possible to teach all students in identical ways and have all of them receive an equal education? How do we achieve equity in science classrooms? First we must recognize that teaching habits differentially affect various populations in our classrooms (Brown University, 1996). Attention must be given to curricula content and teaching techniques to determine how they might be changed to be more attractive to the needed groups (Rosser, 1993). By using teaching techniques that recognize a variety of learning styles in the classroom, all students, male and female would benefit. More students who are not learning under the standard lecture-style, large-class, science education system would be served.

In observing classroom dynamics, studies have shown that males tend to respond to questions more confidently, aggressively, and quickly, regardless of the quality of their responses; they tend to speak more freely and spontaneously in class, formulating their answers as they speak. Females tend to wait longer to respond to a question, choosing their words carefully, reflecting on the question and constructing an answer before they speak. Inevitably male students interrupt them. Consequently they infer that their contributions are not as valuable, and thereby distance themselves during future discussions. The following are recommendations for the teacher to consider: encourage class participation, be aware of whom you are calling upon, seek outside feedback about your lecture style and dynamics in the classroom, monitor language and materials for gender neutral language, and posing a question after class extending the time for reflection (Brown University, 1996).

Another problem encounter by female students is large class sizes. When asked why they dislike them, female students respond that they are impersonal, that the professor didn't know who they were and that they felt isolated. Female students look for direct encouragement and personal feedback. Recommendations include encouraging the use of study groups, use more writing exercises, and rearrange classroom setting (Brown University, 1996).

It is also highly encouraged to shift from a competitive to a cooperative educational model. Studies have shown that many students that leave the sciences are intelligent and strongly motivated, but are discouraged by the competitive atmosphere. Students often respond more positively to an atmosphere of cooperative learning. This involves small groups of students working together to solve problems, complete a task or accomplish a common goal. "Small groups provide a forum in which students ask questions, discuss ideas, make mistakes, learn to listen to others' ideas, offer constructive criticism, and summarize their discoveries in writing " (Brown University, 1996). Again utilizing cooperative and collaborative work that is more discovery-oriented and explores interesting topics while not ignoring the basics is recommended.

Female students also tend to develop extremely high standards for themselves as prerequisites for staying in science. Students' different learning styles may also cause difficulties with exams, with the student's performance not the only indicator of the students achievement in the course. Explaining the grading system, eliminating the curve, giving a word of encouragement, follow up on a poor performance, consider untimed or take-home exams, or varying the exam structure are recommended (Brown University, 1996).

Women in our society often have an extrinsic sense of self worth. They are more likely to place a higher value on what others think of them than men do. When encountering problems, women tend to cite their own inadequacy as the source of difficulty. Men place responsibility or blame for problems on external sources. Women are generally less confident in their abilities and are more willing to believe that they are unintelligent when examining poor performance. As a teacher, one should provide personal encouragement, and choose activities that foster a students' confidence (Brown University, 1996).

In addition to the above, teachers should periodically check that they are paying equal attention to girls and boys, have equal numbers of girls leading groups, have all students do hands-on-activities, have all students be aware of the importance of math and science in future career decisions, make sure girls feel comfortable asking questions and are given supportive answers, and see that girls don't defer to boys and that boys don't expect them to (Lackey, 1995).

Changing attitudes, teaching methods and curriculum all need to be done to promote equality between male and female students (Malloy, 1996). Lessons need to teach students to think and analyze, to arrive at solutions rather than on the answer itself. The female learning style seems to parallel what research suggests as an ideal teaching method. Modern teaching methods involve student discovery and cooperative learning, thereby impressing affective change in female achievement.

Studies on Mastery Learning and Gender Differences:

F. Gerald Dillashaw studied the effects of a modified mastery learning strategy on achievement, attitudes, and on-task behavior of high school chemistry students. In his study, mastery learning was modified to include only two cycles of remediation. The students were assigned to three different treatment groups associated with 1) no remediation, 2) student-managed remediation, and 3) teacher-managed remediation. Block and Burns concluded in an earlier study that mastery learning students achieved significantly higher than non-mastery students when compared (Dillashaw, 1981). Yet there had been very little research studying the relationship between student-directed versus teacher-directed remediation, although both groups have been shown to outscore non-remediation groups. The question to be asked then was, do student-directed differ from teacher-directed remediation? One argument made was that students who are more internally controlled would be better able to direct their own remediation than students who are more externally controlled (Dillashaw, 1981). Other research has also shown students on-task behavior is increased with mastery learning procedures (Dillashaw, 1981). Both of these statements must be considered when studying mastery learning. In his conclusion, Dillashaw determines that the mastery learning groups consistently have higher, significant achievement gains than the non-mastery control group. This occurred using only two cycles of diagnostics and remediation. Between the two mastery learning groups, the students in the teacher-directed remediation group achieved significantly higher than the student-remediation group only on the first achievement test (Dillashaw, 1981). There was no significant difference found between the two groups on later achievement measures. Dillashaw contends that this is due to a slower learning curve by the student-managed remediation group to recognize the benefits of mastery learning. Once the benefits were apparent, the students were more attentive to diagnostic tests and remediation (Dillashaw,19819). In terms of on-task behavior, a positive effect was exhibited in both mastery learning groups, than on the control. In his implications, Dillashaw contends that instructional strategies such as mastery learning can affect achievement in a high school chemistry classroom. Also the high school chemistry teacher is more willing to expand his remediation activities with the assumption that having them available may be sufficient to increase achievement (Dillashaw, 1981). Also using diagnostic tests focuses the attention of the student on specific objectives to be assessed thus bringing about achievement gains (Dillashaw, 1981). Lastly, Dillashaw states that mastery learning strategies enhances the management of a classroom, in turn increasing on-task behavior that enhances achievement gains (Dillashaw, 1981).

James D. Allen studied the student differences in attribution and motivation toward the study of high school regents earth science. In particular, the attributions of low achieving students toward the controllable factor "effort", was studied (Allen, 1991). As a subpopulation, female students were shown to exhibit higher percentage of shifts in attributions toward effort than males. Using a mastery learning strategy for one unit in the regents earth science curriculum, Allen suggests that students would shift their attribution of low science achievement away from "ability" to "effort" and there would then be a corresponding increase in the student's effort towards the unit of study (Allen, 1991). Students were required to attain 100% mastery on the test for this unit. For students not reaching mastery, corrective instruction was made available. It was hypothesized that by requiring students to achieve a "perfect" score, extended effort would be required of all students and achievement could not be solely based on ability (Allen, 1991). Allen concluded from his study that students could be encouraged to take more demanding science courses and be successful if supportive methods related to the effort put forth in mastering concepts were used (Allen, 1991). He also showed that female students are more likely to attribute success to effort. This is especially significant since female students are less frequently found in upper high school courses, which in turn limit their opportunities for further studies (Allen, 1991).

In the last study looked at, Sandra H. Harpole studied the relationship of gender and learning styles to achievement and laboratory skills in secondary school chemistry students. The study focused on differences between male and female students. The purpose of the study was to determine the relationship of gender and learning styles to achievement and laboratory skills (Harpole, 1987). The primary conclusions of this study were that male students worked better with numbers and logic and benefited from course work that was logically and clearly organized. Female students benefited from situations that were people-oriented and where goals were set and feedback was used to modify procedures (Harpole, 1987). Also female student were found to work better in group situations where they can help each other than individually. Male students were more competitive and found problems involving computing and solving mathematical problems more meaningful (Harpole, 1987).

Research Study:

This research study will compare two testing strategies in a high school regents chemistry course. The first testing strategy allows the student to retake a quiz or test three times on each instructional unit. The student is not required to attain an 80% or better mastery level and is only required to take the test once if so desired. The student's grade for that instructional unit is then recorded as the average of all the quizzes or tests taken. This testing strategy will be identified as "Averaging" throughout the following text. The second testing strategy requires the student to successfully attain eighty percent (80%) or better mastery level on each instructional unit. The student's grade is then recorded to be an 80, 90, or 100 depending on when the student reaches mastery level. If the student does not achieve mastery level, the grade is recorded as 0. This testing strategy will be identified as "Mastery Testing" throughout the following text.

Two different instructors administered each testing strategy. Both are veteran teachers with more than fifteen years (15) experience teaching regents chemistry. The instructional units were divided into 31 units, (see Table 1 below). Each instructional unit was taught using traditional teaching methods (lecture) and cooperative activities. In each testing strategy, students where expected to do additional remediation activities as necessary, but there were no formal teacher managed assignments given. Together the instructors developed each instructional unit test. These tests were developed to reflect the student's ability to apply the concepts in that instructional unit using different "data". That is, the same concept is tested in each question. The data in the question is changed for each retake of the quiz. Each teacher used the same test for each instructional unit. Therefore the tests are controllable variables in this study. The obvious uncontrollable variables are the student's own motivation in learning and testing and the instructors teaching methods.

Numbered Unit	*Unit*	*Numbered Unit*	*Unit*
1	Background	17	Chem Math 1
2	Matter & Energy	18	Chem Math 2
3	Gas	19	Chem Math Unit
4	Liquid/Solid	20	Kinetics & Equilibrium
5	Matter & Energy Unit	21	Delta G/Ksp
6	Nucleon	22	Kinetics Unit
7	Electron	23	Acids/Bases
8	Radioactivity	24	Ka/pH
9	Atomic Unit	25	Acids/Bases Unit
10	Bonding	26	Redox
11	Forces of Attraction	27	Electrochemistry
12	Formulas/Naming	28	Redox Unit
13	Bonding Unit	29	Organic Molecule
14	Periodic Table	30	Organic Reactions
15	Chemical Families	31	Organic Unit
16	Periodic Table Unit		

Table 1: Numbered Regents Chemistry Instructional Units

In comparing the two testing strategies the author will look at the following comparisons:

1. comparison of average grade per instructional unit (also including regents exam results)
2. comparison of gender results per testing strategy in
    a. average grade per instructional unit
    b. passing result per instructional unit
    c. achieving 80% or above per instructional unit
    d. number of trials needed or taken to achieve the recorded grade

The following hypotheses will be tested:

Hypothesis #1:

There will be no statistical significant difference (s.s.d.) between the means of the overall averages of the averaging testing strategy (Sample A) and the mastery testing strategy (Sample B) for each instructional unit.

Hypothesis #2:

There will be no statistical significant difference (s.s.d) between the means of the averages of the female students (Sample A_f) and the male students (Sample A_m) in the averaging testing strategy for each instructional unit.

Hypothesis #3:

There will be no statistical significant difference (s.s.d) between the means of the averages of the female students (Sample B_f) and the male students (Sample B_m) in the mastery testing strategy for each instructional unit.

Hypothesis #4:

There will be no statistical significant difference (s.s.d) between the means of the averages of the female students in the averaging testing strategy (Sample A_f) and the female students in the mastery testing strategy (Sample B_f) for each instructional unit.

Hypothesis #5:

There will be no statistical significant difference (s.s.d) between the means of the averages of the male students in the averaging testing strategy (Sample A_m) and the male students in the mastery testing strategy (Sample B_m) for each instructional unit.

Hypothesis #6:

There will be no statistical significant difference (s.s.d.) between the number of trials needed to achieve recorded grade of the averaging testing strategy (Sample A) and the mastery testing strategy (Sample B) for each instructional unit.

Hypothesis #7:

There will be no statistical significant difference (s.s.d) between the number of trials needed to achieve recorded grade of the female students (Sample A_f) and the male students (Sample A_m) in the averaging testing strategy for each instructional unit.

Hypothesis #8:

There will be no statistical significant difference (s.s.d) between the number of trials needed to achieve recorded grade of the female students (Sample B_f) and the male students (Sample B_m) in the mastery testing strategy for each instructional unit.

Hypothesis #9:

There will be no statistical significant difference (s.s.d) between the number of trials needed to achieve recorded grade of the female students in the averaging testing strategy (Sample A_f) and the female students in the mastery testing strategy (Sample B_f) for each instructional unit.

Hypothesis #10:

There will be no statistical significant difference (s.s.d) between the number of trials needed to achieve recorded grade of the male students in the averaging testing strategy (Sample A_m) and the male students in the mastery testing strategy (Sample B_m) for each instructional unit.

Research Study Results:

A compilation of results for the averaging testing strategy (Table A1) and the mastery testing strategy (Table A2) appear in the appendix at the end.

The following null hypothesis was tested using a student t-test at the α=0.05 confidence level for each of the above hypothesis.

H_o: $\mu_1 - \mu_2 = 0$

H_a: $\mu_1 - \mu_2 \neq 0$

The null hypothesis was rejected when the $t_{stat} > t_{critical}$

Hypothesis #1:

The t-test results for comparisons of quiz/test averages for the averaging testing strategy to the mastery testing strategy are in Table A3 of the appendix. Comparison of regents test scores for each testing strategy does not allow for rejection of the null hypothesis, H_o, indicating that there is no statistical significant difference. Yet in twenty (20) of the instructional units, the null hypothesis H_o is rejected. This can be interpreted as follows: the testing method does significantly affect results on the teacher developed instructional unit quizzes/tests, but the testing strategy does not allow for one testing strategy to be preferred over the other as indicated by this set of data in relationship to regents exam achievement.

Hypothesis #2:

The t-test results for comparisons of the female quiz averages to male quiz averages in the averaging testing strategy are in Table A4 of the appendix. Comparison of regents test scores for each testing strategy does allow for rejection of the null hypothesis, H_o, indicating that there is a statistical significant difference. In comparisons of the instructional units there are only two (2) units where the null hypothesis H_o is rejected. This can be interpreted as follows: the averaging testing strategy does affect the outcome of regents test scores in these sub populations even though there appears to be no statistical significant difference throughout the year on the teacher developed quizzes/test.

Hypothesis #3:

The t-test results for comparisons of the female quiz averages to male quiz averages in the mastery testing strategy are in Table A5 of the appendix. Comparison of regents test scores for each testing strategy does not allow for rejection of the null hypothesis, H_o, indicating that there is no statistical significant difference. In comparisons of the instructional units there is only one (1) unit where the null hypothesis H_o is rejected. This can be interpreted as follows: the mastery testing strategy does not affect the outcome in either the regents test scores or the teacher developed quizzes/test in these sub populations.

Hypothesis #4:

The t-test results for comparisons of the female quiz averages of the averaging testing strategy to the female quiz averages in the mastery testing strategy are in Table A6 of the appendix. Comparison of regents test scores for each testing strategy does not allow for rejection of the null hypothesis, H_o, indicating that there is no statistical significant difference. In comparisons of the instructional units there are seven (7) units where the null hypothesis H_o is rejected. This can be interpreted as follows: although there is a statistical significant difference in some of the teacher developed instructional unit quizzes/tests, it does not occur in a majority of these units and therefore it can not be concluded that the testing strategy affects the outcome of results. The testing strategy also does not seem to affect the outcome of regents scores.

Hypothesis #5:

The t-test results for comparisons of the male quiz averages of the averaging testing strategy to the male quiz averages in the mastery testing strategy are in Table A7 of the appendix. Comparison of regents test scores for each testing strategy does not allow for rejection of the null hypothesis, H_o, indicating that there is no statistical significant difference. In comparisons of the instructional units there are fifteen (15) units where the null hypothesis H_o is rejected. This can be interpreted as follows: although there is a statistical significant difference in half of the teacher developed instructional unit quizzes/tests, it would be difficult to conclude that the testing strategy affects the outcome of results. The testing strategy also does not seem to affect the outcome of regents scores.

A compilation of results for the number of trials needed in the averaging testing strategy and the mastery testing strategy appear in Table A8 in the appendix.

Hypothesis #6:

The t-test results for comparisons of the number of trials needed to achieve recorded grade for the averaging testing strategy to the mastery testing strategy are in Table A9 of the appendix. In seventeen (17) of the instructional units, the null hypothesis H_o is rejected. This can be interpreted as follows: since the null hypothesis H_o is rejected in more than one-half of the instructional units, this would appear that the testing strategies are statistically different in terms of trials needed for each instructional unit quiz/test.

Hypothesis #7:

The t-test results for comparisons of the number of trials needed to achieve recorded grade for female students to male students in the averaging testing strategy are in Table A10 of the appendix. In comparisons of the instructional units there are only two (2) units where the null hypothesis H_o is rejected. This can be interpreted as follows: the averaging testing strategy does not affect the number of trials needed to achieve recorded grade in these sub populations.

Hypothesis #8:

The t-test results for comparisons of the number of trials needed to achieve recorded grade for female students to male students in the mastery testing strategy are in Table A11 of the appendix. In comparisons of the instructional units there are only four (4) units where the null hypothesis H_o is rejected. This can be interpreted as follows: the mastery testing strategy does not affect the number of trials needed to achieve recorded grade in these sub populations.

Hypothesis #9:

The t-test results for comparisons of the number of trials needed to achieve recorded grade for female students in the averaging testing strategy to the female students in the mastery testing strategy are in Table A12 of the appendix. In comparisons of the instructional units there are seventeen (17) units where the null hypothesis H_o is rejected. This can be interpreted as follows: since there is statistical difference in more than half of the instructional units, it would appear that the testing strategies affect the average number of trials needed to achieve recorded grade in these sub populations.

Hypothesis #10:

The t-test results for comparisons of the number of trials needed to achieve recorded grade for male students in the averaging testing strategy to the male students in the mastery testing strategy are in Table A13 of the appendix. In comparisons of the instructional units there are thirteen (13) units where the null hypothesis H_o is rejected. This can be interpreted as follows: although there is a statistical significant difference in almost half of the instructional units, it would be difficult to conclude that the testing strategies affect the number of trials needed to achieve recorded grade in these sub populations.

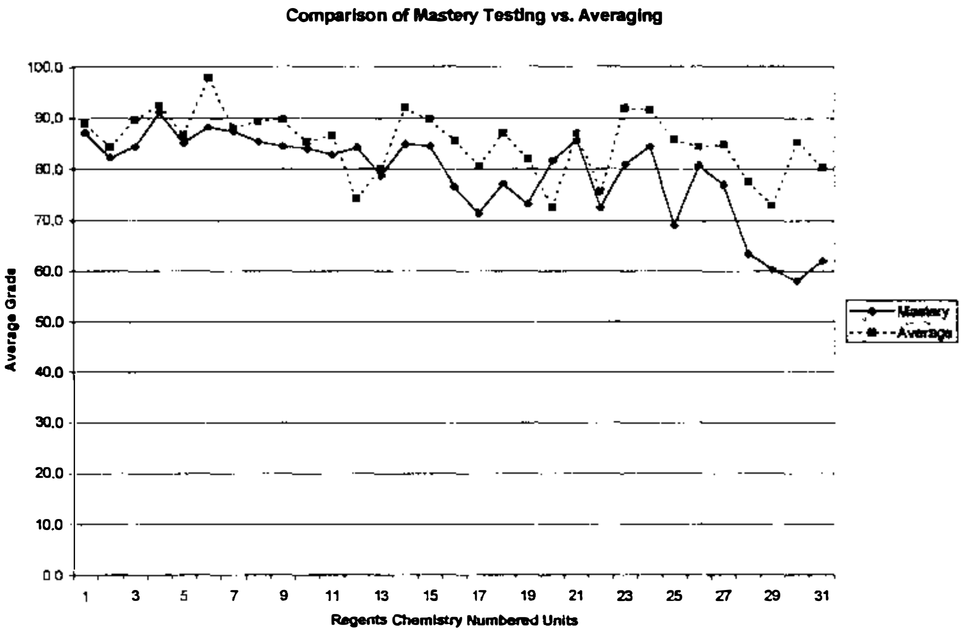
Other Observable Results:

In comparing the averaging testing strategy with the mastery testing strategy, other results can be observed by looking at the percentage of students passing and the percentage of students achieving an 80% or higher on both the regents exam and for each instructional unit. Table 2 below shows the results for both strategies.

	Averaging Testing Strategy	*Mastery Testing Strategy*
Regents Exam Average	73.8	72.5
Percentage Passing	74.4	73.3
Percentage Achieving 80% or higher	32.1	46.7
Inst. Unit Grade Average	85.1	78.9
Percentage Passing	90.3	91.9
Percentage Achieving 80% or higher	76.8	91.9

Table 2: Comparison of Testing Strategy Indicators

Where there appears to be no discernable difference in the testing strategies when examining exam averages and passing percentages, there is a noticeable difference in the percentage of students achieving 80% or higher, both for the regents exam and for the instructional units. This is shown below graphically on Graph 1: Comparison of Mastery Testing vs. Averaging. (A full size graph appears in the appendix, Graph A1).



Graph 1: Comparison of Mastery Testing vs. Averaging

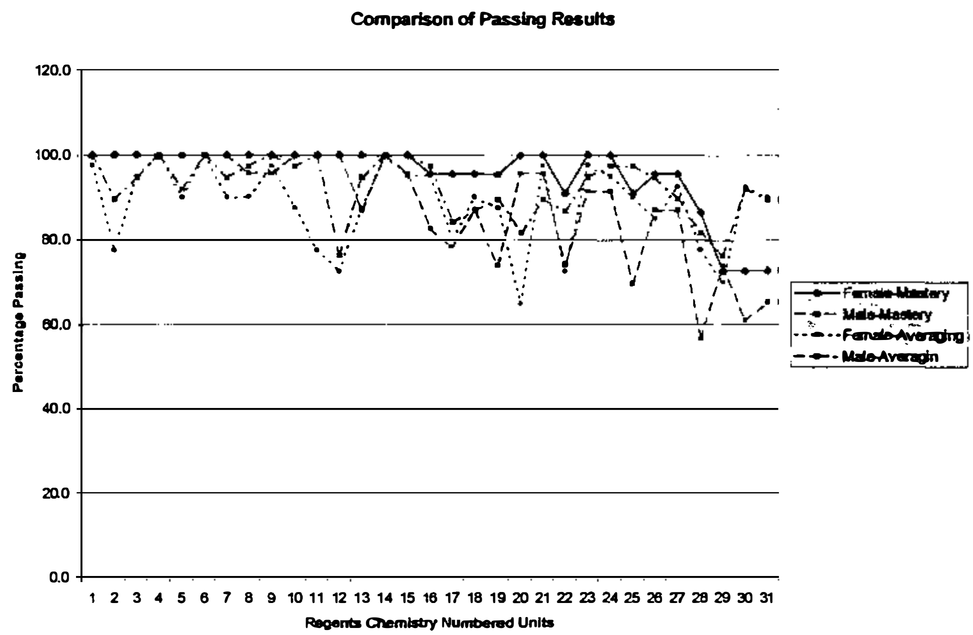
On closer inspection of the instructional units, it can be determined that in eighteen (18) of the units, the students in the mastery testing sample have a higher passing percentage or in 58.1% of the total number of units. In thirty (30) of the units, the students in the mastery testing sample have a higher percentage of students achieving 80% or higher or in 96.8% of the total number of units. There appears then to be a casual relationship indicating that students in the mastery testing sample, although have no different passing percentage when compared with students in the averaging testing sample, do have an advantage in achieving a higher grade not only in each instructional unit but also on the regents exam.

Comparing the same results above using gender sub populations, the results are shown below in Table 3.

	Female-Averaging	*Female-Mastery*	*Male-Averaging*	*Male-Mastery*
Regents Exam Average	69.6	73.7	78.3	71.4
Percentage Passing	67.5	72.7	81.6	73.9
Percentage Achieving 80% or higher	15.0	40.9	52.6	52.2
Inst. Unit Grade Average	83.7	81.9	86.6	76.5
Percentage Passing	88.2	95.5	92.4	88.5
Percentage Achieving 80% or higher	73.1	95.5	80.6	88.5

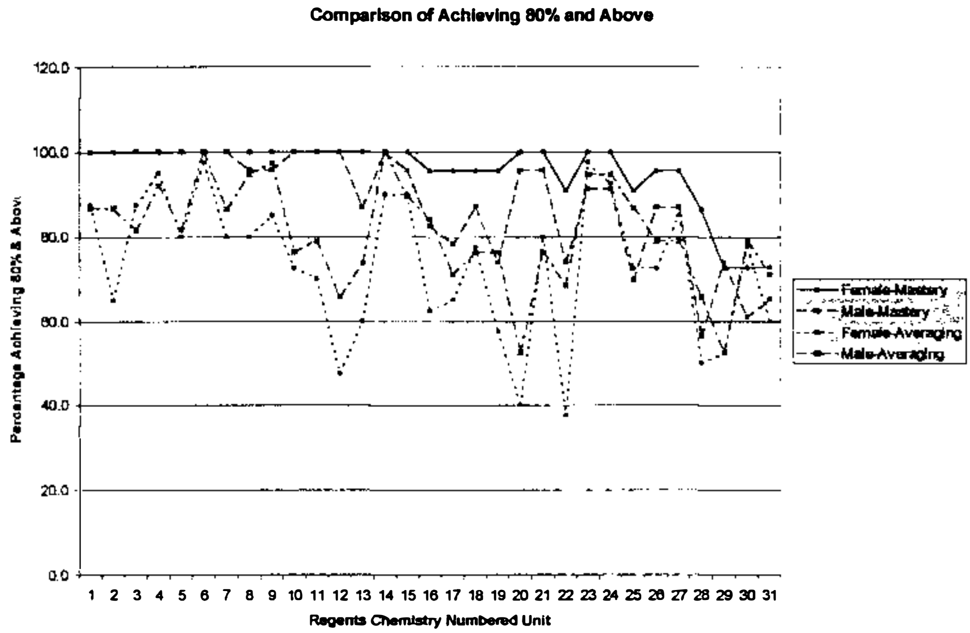
Table 3: Comparison of Testing Strategy Indicators per gender

As seen above, there appears to be no discernable difference in the testing strategies when comparing exam averages. The scores range from 69.6 to 78.3, which is an 8.7 point difference. When comparing passing percentages the scores range from 67.5 to 81.6 widening the range slightly to 14.1. But when comparing the percentage of students achieving 80% or higher, there is a dramatic difference between the female students in the averaging testing sample when compared with the other three samples. Only 15.0% of female students in the averaging sample achieved an 80% or higher exam score. When comparing the male exam scores there is only a .4 difference in scores allowing that there is no difference. But when looking at the female students in the mastery testing sample this result is a 40.9. Lower than the male results (11.7 point difference), but significantly higher than the same result for female students in the averaging testing sample (25.9 point difference). This would seem to indicate that although the testing strategies do not affect the passing percentages, it does affect achievement level of the exam scores of female students. If we continue to look at the same results for each individual instructional unit, we see the same trends. Graph 2: Comparison of Passing Results, (A full size graph appears in the appendix, Graph A2) below graphically represents the comparisons of passing percentages per testing strategy per gender. At the beginning of the year, students' achievement is similar, with female students in the averaging sample to be the lowest. Towards the end of the year, as coursework becomes more difficult, the passing percentages become lower, yet it is the female students in the mastery testing sample that continue to have the highest passing percentages.



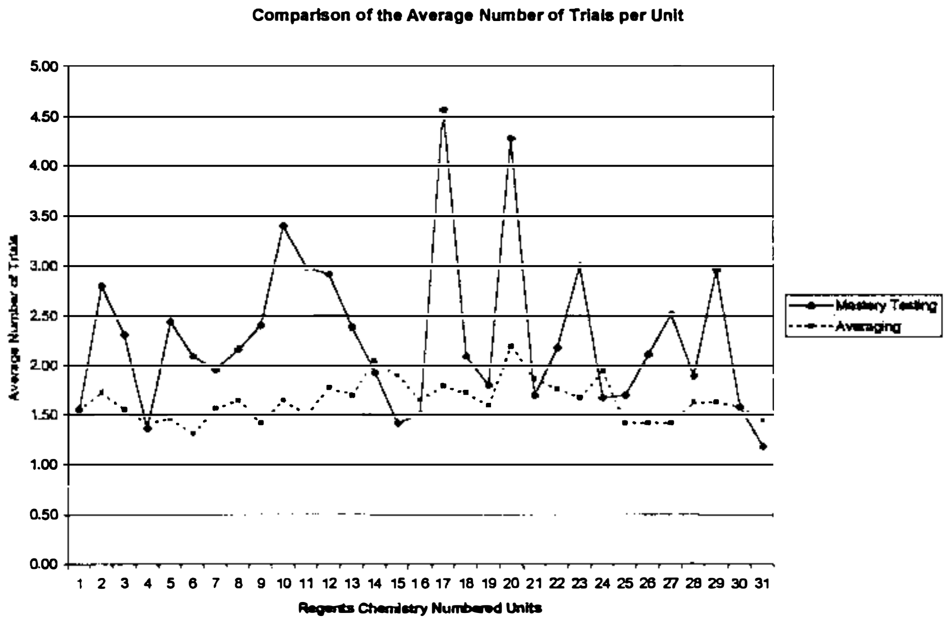
Graph 2: Comparison of Passing Results

Female students in the mastery testing sample also appear to have an advantage over other students when looking at the percentage of students achieving 80% or higher, whereas female student in the averaging testing sample appear to be at a disadvantage. This is shown below in Graph 3: Comparison of Achieving 80% and Above. (A full size graph appears in the appendix, Graph A3)

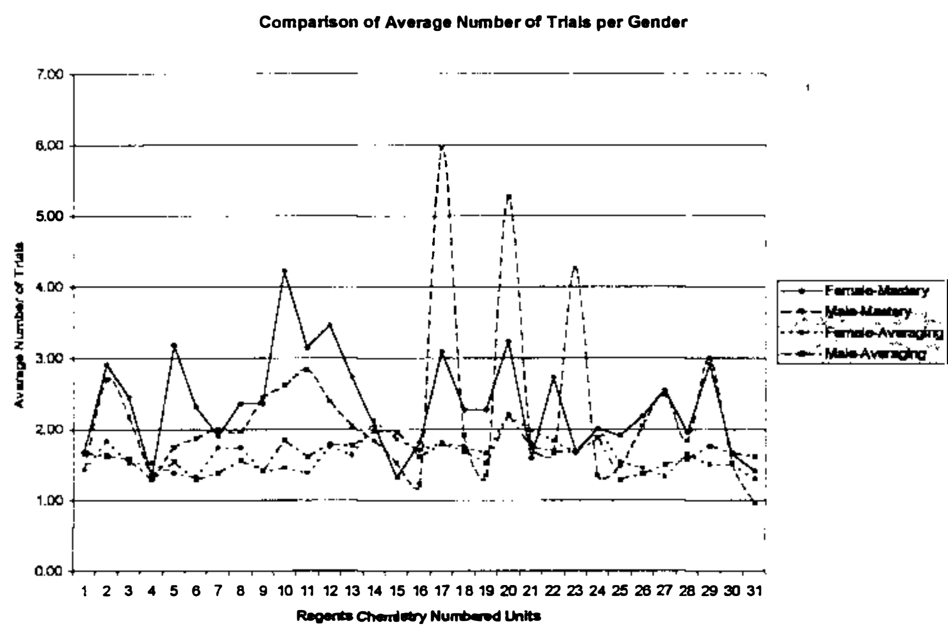


Graph 3: Comparison of Achieving 80% and Above

Lastly, when comparing the average number of trials taken for each individual unit, we see that students in the mastery testing sample require more trials to attain their recorded grade score. (See Graph 4: Comparison of the Average Number of Trials Per Unit, below). When comparing female students to male students in the two testing strategies, there is no discernable difference between male and female students in the averaging testing sample. Yet the female students in the mastery testing sample have a higher average number of trials, with the exception of approximately 3 individual units where male students in the mastery testing sample require significantly more trials. (See Graph 5: Comparison of the Average Number of Trials Per Gender, below). (A full size graph of each appears in the appendix, Graph A4 & Graph A5)



Graph 4: Comparison of the Average Number of Trials Per Unit



Graph 5: Comparison of the Average Number of Trials Per Gender

Conclusions & Implications:

From this study, there appears to be no significant difference between a mastery testing strategy when compared to an averaging testing strategy on achievement of the regents chemistry exam. In contrast, there does appear to be a significant difference when comparing the instructional units in the regents chemistry curriculum. And further, female students using the mastery testing strategy achieve higher scores than female students using the averaging testing strategy, although there is no significant difference between male students in both testing strategies. This should be especially noted. When considering learning styles of female students in comparison to male students, mastery learning and testing affects many of the recommendations listed to improve gender equality in classroom dynamics. Female students, when required to attain a mastery level no longer internally equate achievement with ability; rather they see that achievement can be attained through effort. Female students tend to continually challenge mastery tests to attain the mastery level. When required to attain mastery, the "nerdy" façade is withdrawn since all female students must attain the same level of achievement. Male students tend to view achievement based on ability and will exert little effort to continue challenging mastery tests to attain the mastery level. Instead their frustrations will cause the student to discontinue taking the test, internalizing this as a "I can't do it" belief. This is supported by looking at the number of times a female student will challenge a test compared to male students, in both testing strategies. It should be noted that male students in the averaging testing strategy actually score higher in many of the later instructional units. The instructional units are taught sequentially and the units where male students in the averaging testing strategy appear stronger than male students in the mastery strategy are units that are taught towards the end of the school year. Since students can not continue into the next unit without complete mastery of the current unit, the results are compatible and logically inferred. Male students in the mastery testing strategy stop challenging the tests to attain mastery thereby affecting results of the instructional units in the continuing sequence.

In the end, when considering the dynamics in a classroom, a teacher should choose a strategy that is beneficial to all/or most students in the class. This researcher concludes that mastery learning and testing is a valuable method to increase achievement in the regents chemistry curriculum.

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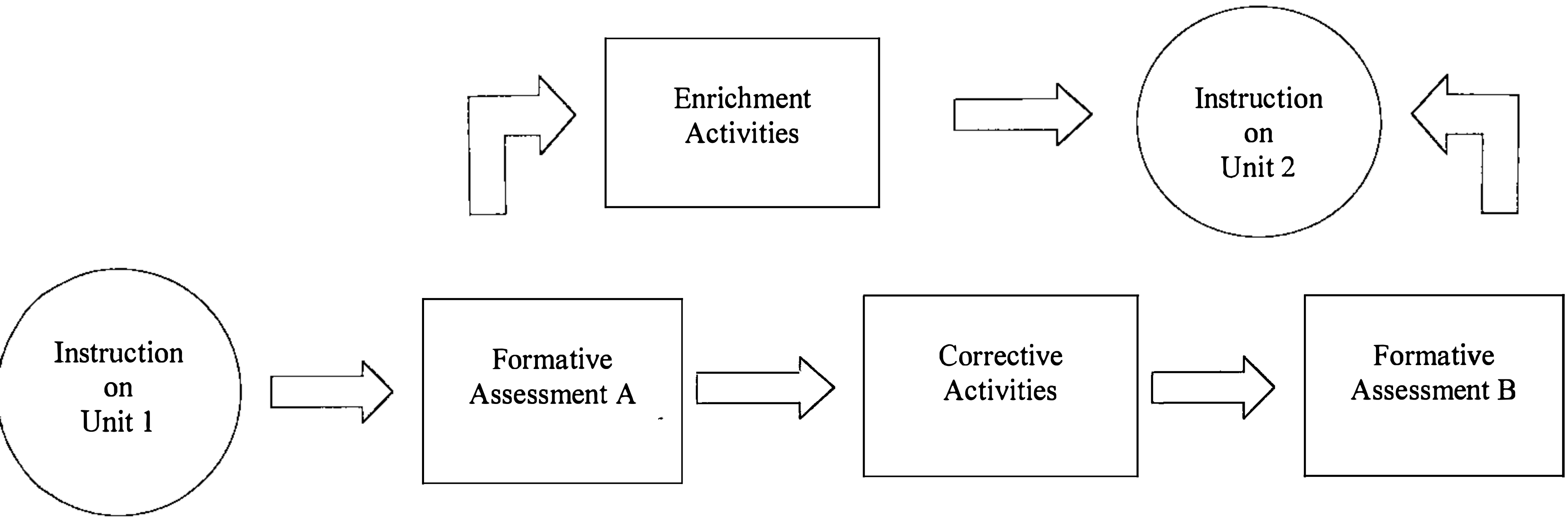
Appendix – Figure A1

The Mastery Learning Instructional Process



Appendix - Table A1

Results of Average Testing Strategy per Unit

Units	No. of Students	No. of Female Students	No. of Male Students	Average Grade	Average Grade Female	Average Grade Male	No. Students Passing	No. Students Passing-Female	No. Students Passing-Male
REGENTS	78	40	38	73.8	69.6	78.3	58	27	31
BCKGRND	78	40	38	88.8	89.4	88.2	77	39	38
M & E	78	40	38	84.2	81.5	87.1	65	31	34
GAS	78	40	38	89.6	90.0	89.3	74	38	,6
LIQ & SOL	78	40	38	92.5	91.4	93.6	78	40	38
M & E UNIT	78	40	38	86.6	85.3	88.0	71	36	35
NUCLEON	78	40	38	97.8	96.6	98.8	78	40	38
ELECTRON	78	40	38	87.9	86.9	88.9	72	36	36
RADIOACT	78	40	38	89.4	86.8	92.2	73	36	37
ATOMIC UN	78	40	38	89.6	87.8	91.4	77	39	38
BONDING	78	40	38	85.3	83.3	87.4	72	35	37
F OF ATT	78	40	38	86.5	81.5	91.8	69	31	38
NAMING	78	40	38	74.2	73.8	74.6	58	29	29
BOND UNIT	78	40	38	79.9	79.0	80.9	71	35	36
PERIODIC	78	40	38	92.0	90.7	93.3	78	40	38
CHEM FAM	78	40	38	89.6	88.0	91.2	76	38	38
PTBLE UNIT	78	40	38	85.5	83.3	87.8	75	38	37
CMATH I	78	40	38	80.6	79.5	81.8	64	32	32
CMATH 2	78	40	38	86.9	87.5	86.2	69	36	33
CMTH UNIT	78	40	38	82.0	79.0	85.1	69	35	34
K & E	78	40	38	72.4	69.8	75.1	57	26	31
KSP	78	40	38	86.9	88.2	85.6	73	39	34
K & E UNIT	78	40	38	75.5	72.3	78.8	62	29	33
ACID/BASE	78	40	38	91.9	92.9	90.8	75	39	36
Ka & pH	78	40	38	91.5	89.9	93.1	75	38	37
A/B UNIT	78	40	38	85.7	83.2	88.4	73	36	37
REDOX	78	40	38	84.3	80.9	87.9	70	34	36
ELECTRO	78	40	38	84.7	84.8	84.7	71	37	34
REDX UNIT	78	40	38	77.5	75.2	80.0	62	31	31
MOLECULE	78	40	38	72.8	72.0	73.8	57	28	29
REACTIONS	78	40	38	85.3	85.4	85.2	72	37	35
ORG UNIT	78	40	38	80.3	78.3	82.5	70	36	34

Units	Percentage Passing	Percent Passing Female	Percent Passing Male	No. Students Ach. 80% (+)	No. Students Ach. 80% (+)-Female	No. Students Ach. 80% (+)-Male	Percent Students Ach. 80% (+)	Percent Students Ach. 80% (+)-Female	Percent Students Ach. 80% (+)-Male
REGENTS	74.4	67.5	81.6	25	6	20	32.1	15.0	52.6
BCKGRND	98.7	97.5	100.0	68	35	33	87.2	87.5	86.8
M & E	83.3	77.5	89.5	59	26	33	75.6	65.0	86.8
GAS	94.9	95.0	94.7	66	35	31	84.6	87.5	81.6
LIQ & SOL	100.0	100.0	100.0	73	38	35	93.6	95.0	92.1
M & E UNIT	91.0	90.0	92.1	63	32	31	80.0	80.0	81.6
NUCLEON	100.0	100.0	100.0	77	39	38	98.7	97.5	100.0
ELECTRON	92.3	90.0	94.7	65	32	33	83.3	80.0	86.6
RADIOACT	93.6	90.0	97.4	68	32	36	87.2	80.0	94.7
ATOMIC UN	98.7	97.5	100.0	71	34	37	91.0	85.0	97.4
BONDING	92.3	87.5	97.4	58	29	29	74.4	72.5	76.3
F OF ATT	88.5	77.5	100.0	58	28	30	74.4	70.0	78.9
NAMING	74.4	72.5	76.3	44	19	25	56.4	47.5	65.8
BOND UNIT	91.0	87.5	94.7	52	24	28	66.7	60.0	73.7
PERIODIC	100.0	100.0	100.0	74	36	38	94.9	90.0	100.0
CHEM FAM	97.4	95.0	100.0	70	36	34	89.7	90.0	89.5
PTBLE UNIT	96.2	95.0	97.4	57	25	32	73.1	62.5	84.2
CMATH I	82.1	80.0	84.2	53	26	27	67.9	65.0	71.1
CMATH 2	88.5	90.0	86.8	60	31	29	76.9	77.5	76.3
CMTH UNIT	88.5	87.5	89.5	52	23	29	66.7	57.5	76.3
K & E	73.1	65.0	81.6	36	16	20	46.2	40.0	52.6
KSP	93.6	97.5	89.5	61	32	29	78.2	80.0	76.3
K & E UNIT	79.5	72.5	86.8	41	15	26	52.6	37.5	68.4
ACID/BASE	96.2	97.5	94.7	75	39	36	96.2	97.5	94.7
Ka & pH	96.2	95.0	97.4	73	37	36	93.6	92.5	94.7
A/B UNIT	93.6	90.0	97.4	62	29	33	79.5	72.5	86.8
REDOX	89.7	85.0	94.7	59	29	30	75.6	72.5	78.9
ELECTRO	91.0	92.5	89.5	64	34	30	82.1	85.0	78.9
REDX UNIT	79.5	77.5	81.6	45	20	25	57.7	50.0	65.8
MOLECULE	73.1	70.0	76.3	41	21	20	52.6	52.5	52.6
REACTIONS	92.3	92.5	92.1	61	31	30	78.2	77.5	78.9
ORG UNIT	89.7	90.0	89.5	51	24	27	65.4	60.0	71.1

Appendix - Table A2

Results of Mastery Testing Strategy per Unit

Units	No. of Students	No. of Female Students	No. of Male Students	Average Grade	Average Grade Female	Average Grade Male	No. Students Passing	No. Students Passing-Female	No. Students Passing-Male
REGENTS	45	22	23	72.5	73.7	71.4	33	16	17
BCKGRND	45	22	23	87.1	85.9	88.3	45	22	23
M & E	45	22	23	82.2	82.7	81.7	45	22	23
GAS	45	22	23	84.4	85.0	83.9	45	22	23
LIQ & SOL	45	22	23	91.1	90.9	91.3	45	22	23
M & E UNIT	45	22	23	85.1	83.2	87.0	45	22	23
NUCLEON	45	22	23	88.2	88.6	87.8	45	22	23
ELECTRON	45	22	23	87.3	88.6	86.1	45	22	23
RADIOACT	45	22	23	85.3	87.7	83.0	44	22	22
ATOMIC UN	45	22	23	84.4	85.9	83.0	44	22	22
BONDING	45	22	23	84.0	84.1	83.9	45	22	23
F OF ATT	45	22	23	82.7	82.7	82.6	45	22	23
NAMING	45	22	23	84.2	83.6	84.8	45	22	23
BOND UNIT	45	22	23	78.7	83.6	73.9	42	22	20
PERIODIC	45	22	23	84.9	83.6	96.1	45	22	23
CHEM FAM	45	22	23	84.4	85.5	83.5	44	22	22
PTBLE UNIT	45	22	23	76.4	80.9	72.2	40	21	19
CMATH I	45	22	23	71.3	78.2	64.8	39	21	18
CMATH 2	45	22	23	77.1	80.5	73.9	41	21	20
CMTH UNIT	45	22	23	73.1	82.7	63.9	38	21	17
K & E	45	22	23	81.6	83.2	80.0	44	22	22
KSP	45	22	23	85.6	88.6	82.6	44	22	23
K & E UNIT	45	22	23	72.4	79.1	66.1	37	20	17
ACID/BASE	45	22	23	80.9	84.5	77.4	43	22	21
Ka & pH	45	22	23	84.4	86.6	82.2	43	22	21
A/B UNIT	45	22	23	68.9	78.2	60.0	36	20	16
REDOX	45	22	23	80.7	85.0	76.5	41	21	20
ELECTRO	45	22	23	76.9	80.5	73.5	41	21	20
REDX UNIT	45	22	23	63.3	77.3	50.0	32	19	13
MOLECULE	45	22	23	60.2	60.5	60.0	33	16	17
REACTIONS	45	22	23	58.0	63.6	52.6	30	16	14
ORG UNIT	45	22	23	62.0	66.4	57.8	31	16	15

Units	Percentage Passing	Percent Passing Female	Percent Passing Male	No. Students Ach. 80% (+)	No. Students Ach. 80% (+)-Female	No. Students Ach. 80% (+)-Male	Percent Students Ach. 80% (+)	Percent Students Ach. 80% (+)-Female	Percent Students Ach. 80% (+)-Male
REGENTS	73.3	72.7	73.9	21	9	12	46.7	40.9	52.2
BCKGRND	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
M & E	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
GAS	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
LIQ & SOL	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
M & E UNIT	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
NUCLEON	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
ELECTRON	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
RADIOACT	97.8	100.0	95.7	44	22	23	97.8	100.0	95.7
ATOMIC UN	97.8	100.0	95.7	44	22	22	97.8	100.0	95.7
BONDING	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
F OF ATT	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
NAMING	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
BOND UNIT	93.3	100.0	87.0	42	22	20	93.3	100.0	87.0
PERIODIC	100.0	100.0	100.0	45	22	23	100.0	100.0	100.0
CHEM FAM	97.8	100.0	95.7	44	22	22	97.8	100.0	95.7
PTBLE UNIT	88.9	95.5	82.6	40	21	19	88.9	95.5	82.6
CMATH I	86.7	95.5	78.3	39	21	18	86.7	95.5	78.3
CMATH 2	91.1	95.5	87.0	41	21	20	91.1	95.5	87.0
CMTH UNIT	84.4	95.5	73.9	38	21	17	84.4	95.5	73.9
K & E	97.8	100.0	95.7	44	22	22	97.8	100.0	95.7
KSP	97.8	100.0	95.7	44	22	22	97.8	100.0	95.7
K & E UNIT	82.2	90.9	73.9	37	20	17	82.2	90.9	73.9
ACID/BASE	95.6	100.0	91.3	43	22	21	95.6	100.0	91.3
Ka & pH	95.6	100.0	91.3	43	22	21	95.6	100.0	91.3
A/B UNIT	80.0	90.9	69.6	36	20	16	80.0	90.9	69.6
REDOX	91.1	95.5	87.0	41	21	20	91.1	95.5	87.0
ELECTRO	91.1	95.5	87.0	41	21	20	91.1	95.5	87.0
REDX UNIT	71.1	86.4	56.5	32	19	13	71.1	86.4	56.5
MOLECULE	73.3	72.7	73.9	33	16	17	73.3	72.7	73.9
REACTIONS	66.7	72.7	60.9	30	16	14	66.7	72.7	60.9
ORG UNIT	68.9	72.7	65.2	31	16	15	68.9	72.7	85.2

Appendix - Table A3
t-Test Results for Comparison of Averaging to Mastery Testing Strategies

	Average Mean	No. of Observ.	Mastery Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Regents	73.81	78	72.53	45	121	0.382101	1.979765		Fail to Reject Ho
Background	88.78	78	83.26	45	121	2.900330	1.979765		**Reject Ho**
Matter & Energy	84.19	78	82.22	45	121	0.717022	1.979765		Fail to Reject Ho
Gas	89.62	78	84.44	45	121	2.688084	1.979765		**Reject Ho**
Liquid/Solid	92.46	78	91.11	45	121	0.839077	1.979765		Fail to Reject Ho
Matter & Energy Unit	86.60	78	85.11	45	121	0.683563	1.979765		Fail to Reject Ho
Nucleon	97.82	78	88.22	45	121	8.017819	1.979765		**Reject Ho**
Electron	87.88	78	87.33	45	121	0.206583	1.979765		Fail to Reject Ho
Radioactivity	89.42	78	85.33	45	121	1.542459	1.979765		Fail to Reject Ho
Atomic Unit	89.55	78	84.44	45	121	2.295683	1.979765		**Reject Ho**
Bonding	85.30	78	84.00	45	121	0.483507	1.979765		Fail to Reject Ho
Forces of Attraction	86.47	78	82.67	45	121	1.195368	1.979765		Fail to Reject Ho
Formulas/Naming	74.17	78	84.22	45	121	-2.831727	1.979765		**Reject Ho**
Bonding Unit	79.91	78	78.67	45	121	0.338300	1.979765		Fail to Reject Ho
Periodic Table	91.99	78	84.89	45	121	5.282004	1.979765		**Reject Ho**
Chemical Families	89.59	78	84.44	45	121	2.350898	1.979765		**Reject Ho**
Periodic Table Unit	85.47	78	76.44	45	121	2.486448	1.979765		**Reject Ho**
Chem Math 1	80.62	78	71.33	45	121	2.155425	1.979765		**Reject Ho**
Chem Math 2	86.90	78	77.11	45	121	2.500287	1.979765		**Reject Ho**
Chem Math Unit	82.01	78	73.11	45	121	2.132465	1.979765		**Reject Ho**
Kinetics & Equilibrium	72.35	78	81.55	45	121	-2.857938	1.979765		**Reject Ho**
delta G/ Ksp	86.92	78	85.56	45	121	0.447505	1.979765		Fail to Reject Ho
Kinetics Unit	75.47	78	72.44	45	121	0.643379	1.979765		Fail to Reject Ho
Acids/Bases	91.88	78	80.89	45	121	3.921020	1.979765		**Reject Ho**
Ka/pH	91.45	78	84.44	45	121	2.472396	1.979765		**Reject Ho**
Acids/Bases Unit	85.73	78	68.89	45	121	3.811738	1.979765		**Reject Ho**
Redox	84.32	78	80.67	45	121	0.906244	1.979765		Fail to Reject Ho
Electrochemistry	84.74	78	76.89	45	121	2.207681	1.979765		**Reject Ho**
Redox Unit	77.54	78	63.33	45	121	2.648524	1.979765		**Reject Ho**
Organic Molecule	72.84	78	60.22	45	121	2.283968	1.979765		**Reject Ho**
Organic Reactions	85.30	78	58.00	45	121	5.187963	1.979765		**Reject Ho**
Organic Unit	80.34	78	62.00	45	121	3.506083	1.979765		**Reject Ho**

Appendix - Table A4
t-Test Results of Comparison of Female Students to Male Students Averaging Testing Strategy

	Female Average Mean	No. of Observ.	Male Average Mean	No. of Observ.	df	t Stat	t critical	Reject or Fail to Reject Ho
Quiz/Test Given								
Regents	69.58	40	78.26	38	76	-2.538170	1.991675	Reject Ho
Background	89.38	40	88.16	38	76	0.523047	1.991675	Fail to Reject Ho
Matter & Energy	81.46	40	87.06	38	76	-1.387132	1.991675	Fail to Reject Ho
Gas	89.96	40	89.25	38	76	0.253101	1.991675	Fail to Reject Ho
Liquid/Solid	91.38	40	93.60	38	76	-1.073125	1.991675	Fail to Reject Ho
Matter & Energy Unit	85.25	40	88.03	38	76	-0.897774	1.991675	Fail to Reject Ho
Nucleon	96.92	40	98.77	38	76	-1.587204	1.991675	Fail to Reject Ho
Electron	86.88	40	88.95	38	76	-0.534960	1.991675	Fail to Reject Ho
Radioactivity	86.75	40	92.24	38	76	-1.826299	1.991675	Fail to Reject Ho
Atomic Unit	87.75	40	91.45	38	76	-1.687534	1.991675	Fail to Reject Ho
Bonding	83.29	40	87.41	38	76	-1.042968	1.991675	Fail to Reject Ho
Forces of Attraction	81.46	40	91.75	38	76	-2.218846	1.991675	Reject Ho
Formulas/Naming	73.79	40	74.56	38	76	-0.145182	1.991675	Fail to Reject Ho
Bonding Unit	78.96	40	80.92	38	76	-0.047407	1.991675	Fail to Reject Ho
Periodic Table	90.71	40	93.33	38	76	-1.526915	1.991675	Fail to Reject Ho
Chemical Families	88.04	40	91.23	38	76	-1.480676	1.991675	Fail to Reject Ho
Periodic Table Unit	83.25	40	87.81	38	76	-1.731244	1.991675	Fail to Reject Ho
Chem Math 1	79.50	40	81.80	38	76	-0.527907	1.991675	Fail to Reject Ho
Chem Math 2	87.54	40	86.23	38	76	0.318533	1.991675	Fail to Reject Ho
Chem Math Unit	79.04	40	85.13	38	76	-2.038053	1.991675	Reject Ho
Kinetics & Equilibrium	69.75	40	75.09	38	76	-1.253034	1.991675	Fail to Reject Ho
delta G/ Ksp	88.21	40	85.57	38	76	0.690834	1.991675	Fail to Reject Ho
Kinetics Unit	72.29	40	78.82	38	76	-1.712185	1.991675	Fail to Reject Ho
Acids/Bases	92.88	40	90.83	38	76	0.726786	1.991675	Fail to Reject Ho
Ka/pH	89.88	40	93.11	38	76	-1.270180	1.991675	Fail to Reject Ho
Acids/Bases Unit	83.21	40	88.38	38	76	-1.878734	1.991675	Fail to Reject Ho
Redox	80.92	40	87.89	38	76	-1.756651	1.991675	Fail to Reject Ho
Electrochemistry	84.79	40	84.69	38	76	0.030076	1.991675	Fail to Reject Ho
Redox Unit	77.54	40	80.04	38	76	0.709093	1.991675	Fail to Reject Ho
Organic Molecule	71.96	40	73.77	38	76	-0.327371	1.991675	Fail to Reject Ho
Organic Reactions	85.38	40	85.22	38	76	0.044555	1.991675	Fail to Reject Ho
Organic Unit	78.25	40	82.54	38	76	-1.395557	1.991675	Fail to Reject Ho

Appendix - Table A5
t-Test Results of Female Students to Male Students
Mastery Testing Strategy

	Female Mast. Mean	No. of Observ.	Male Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Regents	73.73	22	71.39	23	43	0.367629	2.016691		Fail to Reject Ho
Background	81.44	22	85.00	23	43	-1.189905	2.016691		Fail to Reject Ho
Matter & Energy	82.73	22	81.74	23	43	0.636099	2.016691		Fail to Reject Ho
Gas	89.25	22	83.91	23	43	1.886119	2.016691		Fail to Reject Ho
Liquid/Solid	90.91	22	91.30	23	43	-0.175853	2.016691		Fail to Reject Ho
Matter & Energy Unit	83.18	22	86.96	23	43	-1.872794	2.016691		Fail to Reject Ho
Nucleon	88.64	22	87.83	23	43	0.333721	2.016691		Fail to Reject Ho
Electron	88.64	22	86.09	23	43	1.193299	2.016691		Fail to Reject Ho
Radioactivity	87.73	22	83.04	23	43	1.026159	2.016691		Fail to Reject Ho
Atomic Unit	85.91	22	83.04	23	43	0.642482	2.016691		Fail to Reject Ho
Bonding	84.09	22	83.91	23	43	0.101676	2.016691		Fail to Reject Ho
Forces of Attraction	82.73	22	82.61	23	43	0.079346	2.016691		Fail to Reject Ho
Formulas/Naming	83.64	22	84.78	23	43	-0.580838	2.016691		Fail to Reject Ho
Bonding Unit	83.64	22	73.91	23	43	1.494850	2.016691		Fail to Reject Ho
Periodic Table	83.64	22	86.09	23	43	-1.323805	2.016691		Fail to Reject Ho
Chemical Families	85.45	22	83.48	23	43	0.446624	2.016691		Fail to Reject Ho
Periodic Table Unit	80.91	22	72.17	23	43	1.042095	2.016691		Fail to Reject Ho
Chem Math 1	78.18	22	64.78	23	43	1.600203	2.016691		Fail to Reject Ho
Chem Math 2	80.45	22	73.91	23	43	0.871467	2.016691		Fail to Reject Ho
Chem Math Unit	82.73	22	63.91	23	43	2.014257	2.016691		Fail to Reject Ho
Kinetics & Equilibrium	83.18	22	80.00	23	43	0.769015	2.016691		Fail to Reject Ho
delta G/ Ksp	88.64	22	82.61	23	43	1.318672	2.016691		Fail to Reject Ho
Kinetics Unit	79.09	22	66.09	23	43	1.252380	2.016691		Fail to Reject Ho
Acids/Bases	84.55	22	77.39	23	43	1.293579	2.016691		Fail to Reject Ho
Ka/pH	86.82	22	82.17	23	43	0.768280	2.016691		Fail to Reject Ho
Acids/Bases Unit	78.18	22	60.00	23	43	1.754457	2.016691		Fail to Reject Ho
Redox	85.00	22	76.52	23	43	1.061034	2.016691		Fail to Reject Ho
Electrochemistry	80.45	22	73.48	23	43	0.929835	2.016691		Fail to Reject Ho
Redox Unit	77.27	22	50.00	23	43	2.312755	2.016691		**Reject Ho**
Organic Molecule	60.45	22	60.00	23	43	0.040840	2.016691		Fail to Reject Ho
Organic Reactions	63.64	22	52.61	23	43	0.878708	2.016691		Fail to Reject Ho
Organic Unit	66.36	22	57.83	23	43	0.666651	2.016691		Fail to Reject Ho

Appendix - Table A6
t-Test Results Comparing Female Students Averaging and Mastery Testing Strategies

	Female Avg. Mean	No. of Observ.	Female Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Regents	69.76	40	73.73	22	60	-0.096048	2.000297		Fail to Reject Ho
Background	89.38	40	81.44	22	60	2.722920	2.000297		Reject Ho
Matter & Energy	81.46	40	82.73	22	60	0.329120	2.000297		Fail to Reject Ho
Gas	89.96	40	85.00	22	60	1.871935	2.000297		Fail to Reject Ho
Liquid/Solid	91.38	40	90.91	22	60	0.203233	2.000297		Fail to Reject Ho
Matter & Energy Unit	85.25	40	83.18	22	60	0.660829	2.000297		Fail to Reject Ho
Nucleon	96.92	40	88.64	22	60	4.077379	2.000297		Reject Ho
Electron	86.88	40	88.64	22	60	-0.484036	2.000297		Fail to Reject Ho
Radioactivity	86.75	40	87.73	22	60	-0.266104	2.000297		Fail to Reject Ho
Atomic Unit	87.75	40	85.91	22	60	0.684954	2.000297		Fail to Reject Ho
Bonding	83.29	40	84.09	22	60	-0.176110	2.000297		Fail to Reject Ho
Forces of Attraction	81.46	40	82.73	22	60	-0.226867	2.000297		Fail to Reject Ho
Formulas/Naming	73.79	40	83.64	22	60	-2.285723	2.000297		Reject Ho
Bonding Unit	78.96	40	83.64	22	60	-1.195966	2.000297		Fail to Reject Ho
Periodic Table	90.71	40	83.64	22	60	3.341719	2.000297		Reject Ho
Chemical Families	88.04	40	85.45	22	60	1.044706	2.000297		Fail to Reject Ho
Periodic Table Unit	83.25	40	80.91	22	60	0.576134	2.000297		Fail to Reject Ho
Chem Math 1	79.50	40	78.18	22	60	0.285006	2.000297		Fail to Reject Ho
Chem Math 2	87.54	40	80.45	22	60	1.687994	2.000297		Fail to Reject Ho
Chem Math Unit	79.04	40	82.73	22	60	-0.894320	2.000297		Fail to Reject Ho
Kinetics & Equilibrium	69.75	40	83.18	22	60	-3.197805	2.000297		Reject Ho
delta G/ Ksp	88.21	40	88.64	22	60	-0.157093	2.000297		Fail to Reject Ho
Kinetics Unit	72.29	40	79.09	22	60	-1.246431	2.000297		Fail to Reject Ho
Acids/Bases	92.88	40	84.55	22	60	3.977767	2.000297		Reject Ho
Ka/pH	89.88	40	86.82	22	60	0.998283	2.000297		Fail to Reject Ho
Acids/Bases Unit	83.21	40	78.18	22	60	1.000092	2.000297		Fail to Reject Ho
Redox	87.89	40	76.52	22	60	1.982105	2.000297		Fail to Reject Ho
Electrochemistry	84.79	40	80.45	22	60	1.089462	2.000297		Fail to Reject Ho
Redox Unit	75.17	40	77.27	22	60	-0.338801	2.000297		Fail to Reject Ho
Organic Molecule	71.96	40	60.45	22	60	1.464061	2.000297		Fail to Reject Ho
Organic Reactions	85.38	40	63.64	22	60	3.097099	2.000297		Reject Ho
Organic Unit	78.25	40	66.36	22	60	1.626404	2.000297		Fail to Reject Ho

Appendix - Table A7
t-Test Results Comparing Male Students
Averaging and Mastery Testing Strategies

	Male Avg. Mean	No. of Observ.	Male Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Regents	78.26	38	71.39	23	59	1.380089	2.000997		Fail to Reject Ho
Background	88.16	38	85.00	23	59	1.283721	2.000997		Fail to Reject Ho
Matter & Energy	87.06	38	81.74	23	59	1.374662	2.000997		Fail to Reject Ho
Gas	89.25	38	83.91	23	59	1.886119	2.000997		Fail to Reject Ho
Liquid/Solid	93.60	38	91.30	23	59	1.014680	2.000997		Fail to Reject Ho
Matter & Energy Unit	88.03	38	86.96	23	59	0.352497	2.000997		Fail to Reject Ho
Nucleon	98.77	38	87.83	23	59	8.624100	2.000997		Reject Ho
Electron	88.95	38	86.09	23	59	0.725084	2.000997		Fail to Reject Ho
Radioactivity	92.24	38	83.04	23	59	2.444633	2.000997		Reject Ho
Atomic Unit	91.45	38	83.07	23	59	2.375856	2.000997		Reject Ho
Bonding	87.41	38	83.91	23	59	1.211078	2.000997		Fail to Reject Ho
Forces of Attraction	91.75	38	82.61	23	59	3.343112	2.000997		Reject Ho
Formulas/Naming	74.56	38	84.78	23	59	-1.785044	2.000997		Fail to Reject Ho
Bonding Unit	80.92	38	73.91	23	59	1.124837	2.000997		Fail to Reject Ho
Periodic Table	93.33	38	86.09	23	59	4.471534	2.000997		Reject Ho
Chemical Families	91.23	38	83.48	23	59	2.138363	2.000997		Reject Ho
Periodic Table Unit	87.81	38	72.17	23	59	2.616597	2.000997		Reject Ho
Chem Math 1	81.80	38	64.78	23	59	2.365141	2.000997		Reject Ho
Chem Math 2	86.23	38	73.91	23	59	1.851016	2.000997		Fail to Reject Ho
Chem Math Unit	85.13	38	63.91	23	59	3.048843	2.000997		Reject Ho
Kinetics & Equilibrium	75.09	38	80.00	23	59	-1.006712	2.000997		Fail to Reject Ho
delta G/ Ksp	85.57	38	82.61	23	59	0.540498	2.000997		Fail to Reject Ho
Kinetics Unit	78.82	38	66.09	23	59	1.684104	2.000997		Fail to Reject Ho
Acids/Bases	90.83	38	77.39	23	59	2.591591	2.000997		Reject Ho
Ka/pH	93.11	38	82.17	23	59	2.288745	2.000997		Reject Ho
Acids/Bases Unit	88.38	38	60.00	23	59	4.043985	2.000997		Reject Ho
Redox	87.89	38	76.52	23	59	1.982105	2.000997		Fail to Reject Ho
Electrochemistry	84.69	38	73.48	23	59	1.893130	2.000997		Fail to Reject Ho
Redox Unit	80.04	38	50.00	23	59	3.638000	2.000997		Reject Ho
Organic Molecule	73.77	38	60.00	23	59	1.743075	2.000997		Fail to Reject Ho
Organic Reactions	85.22	38	52.61	23	59	4.146618	2.000997		Reject Ho
Organic Unit	82.54	38	57.83	23	59	3.285916	2.000997		Reject Ho

Appendix - Table A8
Number of Trials Per Unit Results

	Mastery Testing Strategy			Averaging Testing Strategy		
	Average No. of Trials	Average No. of Trials-Female	Average No. of Trials-Male	Average No. of Trials	Average No. of Trials-Female	Average No. of Trials-Male
BCKGRND	1.56	1.68	1.43	1.54	1.43	1.66
M & E	2.80	2.91	2.70	1.73	1.83	1.63
GAS	2.31	2.45	2.17	1.55	1.53	1.58
LIQ & SOL	1.36	1.32	1.39	1.41	1.53	1.29
M & E UNIT	2.44	3.18	1.74	1.46	1.38	1.55
NUCLEON	2.09	2.32	1.87	1.31	1.33	1.29
ELECTRON	1.96	1.91	2.00	1.56	1.73	1.39
RADIOACT	2.16	2.36	1.96	1.64	1.73	1.55
ATOMIC UN	2.40	2.36	2.43	1.41	1.40	1.42
BONDING	3.40	4.23	2.61	1.64	1.45	1.84
F OF ATT	2.98	3.14	2.83	1.49	1.38	1.61
NAMING	2.91	3.45	2.39	1.77	1.75	1.79
BOND UNIT	2.38	2.73	2.04	1.69	1.63	1.76
PERIODIC	1.93	2.05	1.83	2.05	2.13	1.97
CHEM FAM	1.42	1.32	1.52	1.90	1.85	1.95
PTBLE UNIT	1.51	1.82	1.22	1.65	1.70	1.61
CMATH I	4.56	3.09	5.96	1.79	1.80	1.79
CMATH 2	2.09	2.27	1.91	1.72	1.75	1.68
CMTH UNIT	1.80	2.27	1.35	1.59	1.65	1.53
K & E	4.27	3.23	5.26	2.19	2.20	2.18
KSP	1.69	1.59	1.78	1.86	1.97	1.74
K & E UNIT	2.18	2.73	1.65	1.76	1.83	1.68
ACID/BASE	3.00	1.68	4.26	1.67	1.65	1.68
Ka & pH	1.67	2.00	1.35	1.94	2.00	1.87
A/B UNIT	1.69	1.91	1.48	1.41	1.53	1.29
REDOX	2.11	2.18	2.04	1.41	1.45	1.37
ELECTRO	2.51	2.55	2.48	1.41	1.33	1.50
REDX UNIT	1.89	1.95	1.83	1.62	1.65	1.58
MOLECULE	2.96	2.91	3.00	1.63	1.50	1.76
REACTIONS	1.58	1.64	1.52	1.58	1.50	1.66
ORG UNIT	1.18	1.41	0.96	1.45	1.30	1.61

Appendix - Table A9
t-Test Results Comparing Average Trials Needed
Averaging and Mastery Testing Strategies

	Average Mean	No. of Observ.	Mastery Mean	No. of Observ.	df	t Stat	t critical	Reject or Fail to Reject Ho
Quiz/Test Given								
Background	1.538	78	1.556	45	121	-0.123180	1.979765	Fail to Reject Ho
Matter & Energy	1.731	78	2.800	45	121	-5.541605	1.979765	Reject Ho
Gas	1.551	78	2.311	45	121	-4.534815	1.979765	Reject Ho
Liquid/Solid	1.410	78	1.356	45	121	0.458333	1.979765	Fail to Reject Ho
Matter & Energy Unit	1.462	78	2.444	45	121	-3.412295	1.979765	Reject Ho
Nucleon	1.410	78	2.089	45	121	-3.663021	1.979765	Reject Ho
Electron	1.564	78	1.956	45	121	-1.993883	1.979765	Reject Ho
Radioactivity	1.641	78	2.156	45	121	-2.306307	1.979765	Reject Ho
Atomic Unit	1.410	78	2.400	45	121	-4.115836	1.979765	Reject Ho
Bonding	1.641	78	3.400	45	121	-6.475856	1.979765	Reject Ho
Forces of Attraction	1.487	78	2.978	45	121	-6.155727	1.979765	Reject Ho
Formulas/Naming	1.769	78	2.911	45	121	-4.028006	1.979765	Reject Ho
Bonding Unit	1.692	78	2.378	45	121	-2.464164	1.979765	Reject Ho
Periodic Table	2.051	78	1.933	45	121	0.561070	1.979765	Fail to Reject Ho
Chemical Families	1.897	78	1.422	45	121	3.008408	1.979765	Reject Ho
Periodic Table Unit	1.654	78	1.511	45	121	0.756574	1.979765	Fail to Reject Ho
Chem Math 1	1.795	78	4.556	45	121	-2.772390	1.979765	Reject Ho
Chem Math 2	1.718	78	2.089	45	121	-1.600651	1.979765	Fail to Reject Ho
Chem Math Unit	1.590	78	1.800	45	121	-1.008541	1.979765	Fail to Reject Ho
Kinetics & Equilibrium	2.192	78	4.267	45	121	-2.079790	1.979765	Reject Ho
delta G/ Ksp	1.857	78	1.689	45	121	0.838980	1.979765	Fail to Reject Ho
Kinetics Unit	1.756	78	2.178	45	121	-1.575617	1.979765	Fail to Reject Ho
Acids/Bases	1.666	78	3.000	45	121	-1.342224	1.979765	Fail to Reject Ho
Ka/pH	1.936	78	1.666	45	121	1.546278	1.979765	Fail to Reject Ho
Acids/Bases Unit	1.410	78	1.689	45	121	-1.276501	1.979765	Fail to Reject Ho
Redox	1.410	78	2.111	45	121	-3.242520	1.979765	Reject Ho
Electrochemistry	1.410	78	2.511	45	121	-4.846988	1.979765	Reject Ho
Redox Unit	1.615	78	1.889	45	121	-0.865381	1.979765	Fail to Reject Ho
Organic Molecule	1.628	78	2.956	45	121	-5.164033	1.979765	Reject Ho
Organic Reactions	1.577	78	1.578	45	121	-0.005353	1.979765	Fail to Reject Ho
Organic Unit	1.449	78	1.178	45	121	1.309252	1.979765	Fail to Reject Ho

Appendix - Table A10
t-Test Results Comparing Average Trials Needed for Female and Male Students
Averaging Testing Strategy

	Female Avg. Mean	No. of Observ.	Male Average Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Background	1.425	40	1.658	38	76	-1.316803	1.991675		Fail to Reject Ho
Matter & Energy	1.825	40	1.632	38	76	0.956065	1.991675		Fail to Reject Ho
Gas	1.525	40	1.579	38	76	-0.302068	1.991675		Fail to Reject Ho
Liquid/Solid	1.525	40	1.289	38	76	1.559271	1.991675		Fail to Reject Ho
Matter & Energy Unit	1.375	40	1.553	38	76	-1.070613	1.991675		Fail to Reject Ho
Nucleon	1.400	40	1.421	38	76	-0.137216	1.991675		Fail to Reject Ho
Electron	1.725	40	1.395	38	76	1.712960	1.991675		Fail to Reject Ho
Radioactivity	1.725	40	1.553	38	76	0.891462	1.991675		Fail to Reject Ho
Atomic Unit	1.400	40	1.421	38	76	-0.137216	1.991675		Fail to Reject Ho
Bonding	1.450	40	1.842	38	76	-2.113979	1.991675		**Reject Ho**
Forces of Attraction	1.375	40	1.605	38	76	-1.300153	1.991675		Fail to Reject Ho
Formulas/Naming	1.750	40	1.789	38	76	-0.196418	1.991675		Fail to Reject Ho
Bonding Unit	1.625	40	1.763	38	76	-0.696680	1.991675		Fail to Reject Ho
Periodic Table	2.125	40	1.974	38	76	0.755892	1.991675		Fail to Reject Ho
Chemical Families	1.850	40	1.947	38	76	-0.487857	1.991675		Fail to Reject Ho
Periodic Table Unit	1.700	40	1.605	38	76	0.508142	1.991675		Fail to Reject Ho
Chem Math 1	1.800	40	1.789	38	76	0.055794	1.991675		Fail to Reject Ho
Chem Math 2	1.750	40	1.684	38	76	0.339210	1.991675		Fail to Reject Ho
Chem Math Unit	1.650	40	1.526	38	76	0.729499	1.991675		Fail to Reject Ho
Kinetics & Equilibrium	2.200	40	2.184	38	76	0.079712	1.991675		Fail to Reject Ho
delta G / Ksp	1.974	40	1.737	38	76	1.181436	1.991675		Fail to Reject Ho
Kinetics Unit	1.825	40	1.684	38	76	0.724125	1.991675		Fail to Reject Ho
Acids/Bases	1.650	40	1.684	38	76	-0.173910	1.991675		Fail to Reject Ho
Ka/pH	2.000	40	1.868	38	76	0.686909	1.991675		Fail to Reject Ho
Acids/Bases Unit	1.525	40	1.289	38	76	1.436910	1.991675		Fail to Reject Ho
Redox	1.450	40	1.368	38	76	0.491856	1.991675		Fail to Reject Ho
Electrochemistry	1.325	40	1.500	38	76	-1.150352	1.991675		Fail to Reject Ho
Redox Unit	1.650	40	1.579	38	76	0.410535	1.991675		Fail to Reject Ho
Organic Molecule	1.500	40	1.763	38	76	-1.584177	1.991675		Fail to Reject Ho
Organic Reactions	1.500	40	1.658	38	76	-0.854628	1.991675		Fail to Reject Ho
Organic Unit	1.300	40	1.605	38	76	-2.093850	1.991675		**Reject Ho**

Appendix - Table A11

t-Test Results Comparing Average Trials Needed for Female and Male Students
Mastery Testing Strategy

	Female Mast. Mean	No. of Observ.	Male Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Background	1.682	22	1.435	23	43	1.265494	2.016691		Fail to Reject Ho
Matter & Energy	2.909	22	2.696	23	43	0.574716	2.016691		Fail to Reject Ho
Gas	2.455	22	2.174	23	43	0.883719	2.016691		Fail to Reject Ho
Liquid/Solid	1.318	22	1.391	23	43	-0.425924	2.016691		Fail to Reject Ho
Matter & Energy Unit	3.182	22	1.739	23	43	2.130519	2.016691		**Reject Ho**
Nucleon	2.318	22	1.870	23	43	1.093493	2.016691		Fail to Reject Ho
Electron	1.909	22	2.000	23	43	-0.229575	2.016691		Fail to Reject Ho
Radioactivity	2.364	22	1.957	23	43	0.838257	2.016691		Fail to Reject Ho
Atomic Unit	2.366	22	2.435	23	43	-0.121886	2.016691		Fail to Reject Ho
Bonding	4.227	22	2.609	23	43	2.718973	2.016691		**Reject Ho**
Forces of Attraction	3.136	22	2.826	23	43	0.549971	2.016691		Fail to Reject Ho
Formulas/Naming	3.455	22	2.391	23	43	1.633162	2.016691		Fail to Reject Ho
Bonding Unit	2.727	22	2.043	23	43	1.054481	2.016691		Fail to Reject Ho
Periodic Table	2.045	22	1.826	23	43	0.502194	2.016691		Fail to Reject Ho
Chemical Families	1.318	22	1.522	23	43	-0.869300	2.016691		Fail to Reject Ho
Periodic Table Unit	1.818	22	1.217	23	43	1.611713	2.016691		Fail to Reject Ho
Chem Math 1	3.091	22	5.957	23	43	-1.104364	2.016691		Fail to Reject Ho
Chem Math 2	2.273	22	1.913	23	43	0.698550	2.016691		Fail to Reject Ho
Chem Math Unit	2.273	22	1.348	23	43	2.058808	2.016691		**Reject Ho**
Kinetics & Equilibrium	3.227	22	5.261	23	43	-0.774866	2.016691		Fail to Reject Ho
delta G/ Ksp	1.591	22	1.783	23	43	-0.479654	2.016691		Fail to Reject Ho
Kinetics Unit	2.727	22	1.652	23	43	1.773999	2.016691		Fail to Reject Ho
Acids/Bases	1.682	22	4.261	23	43	-0.990932	2.016691		Fail to Reject Ho
Ka/pH	2.000	22	1.348	23	43	2.132622	2.016691		**Reject Ho**
Acids/Bases Unit	1.909	22	1.478	23	43	0.892483	2.016691		Fail to Reject Ho
Redox	2.182	22	2.043	23	43	0.277425	2.016691		Fail to Reject Ho
Electrochemistry	2.545	22	2.478	23	43	0.123472	2.016691		Fail to Reject Ho
Redox Unit	1.955	22	1.826	23	43	0.163011	2.016691		Fail to Reject Ho
Organic Molecule	2.909	22	3.000	23	43	-0.146645	2.016691		Fail to Reject Ho
Organic Reactions	1.636	22	1.522	23	43	0.415317	2.016691		Fail to Reject Ho
Organic Unit	1.409	22	0.957	23	43	0.939177	2.016691		Fail to Reject Ho

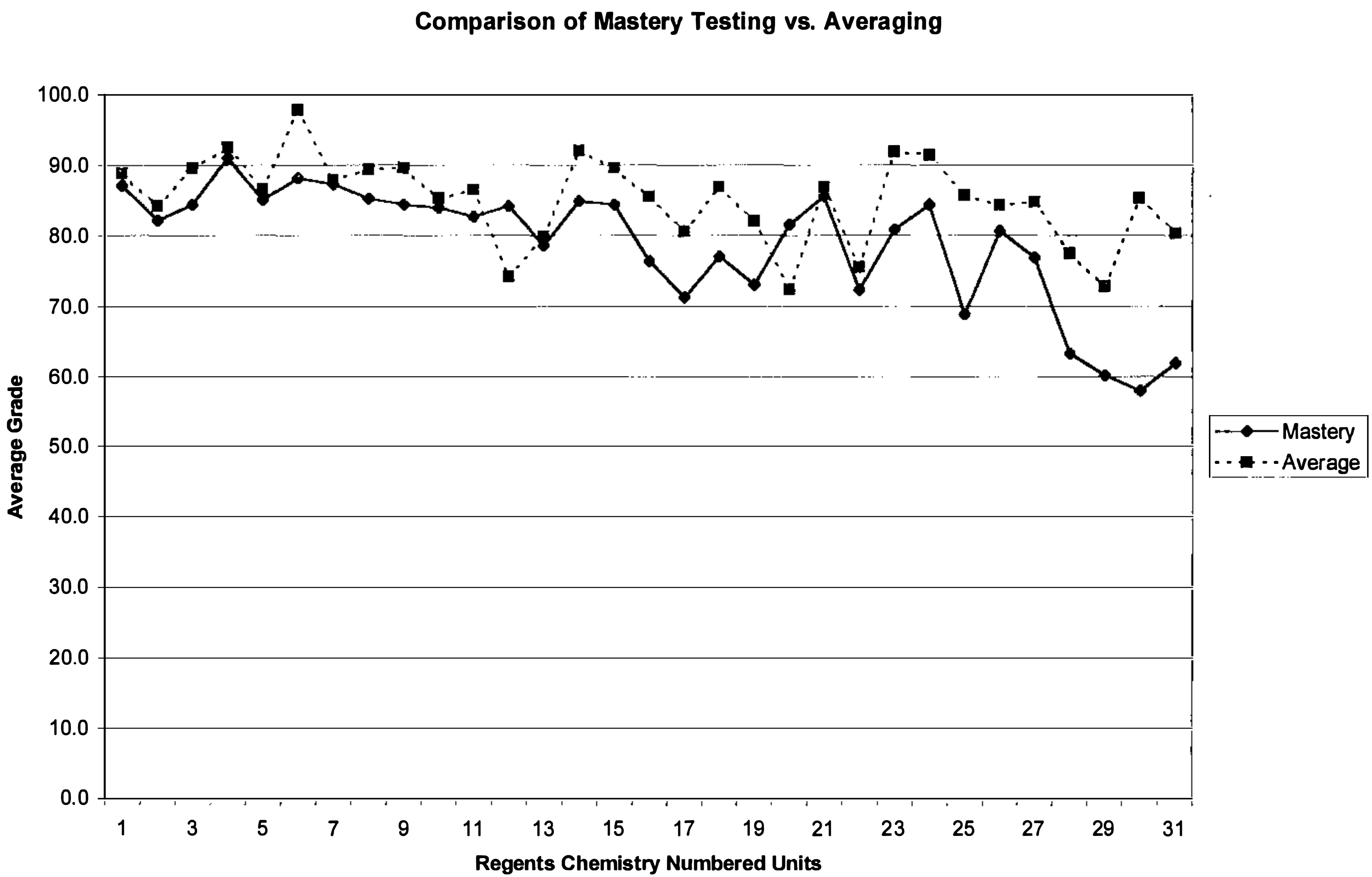
Appendix - Table A12
t-Test Results Comparing Average Trials Needed for Female Students Averaging and Mastery Testing Strategies

	Female Avg. Mean	No. of Observ.	Female Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Background	1.425	40	1.682	22	60	-1.313671	2.000297		Fail to Reject Ho
Matter & Energy	1.825	40	2.909	22	60	-3.792307	2.000297		Reject Ho
Gas	1.525	40	2.455	22	60	-4.214409	2.000297		Reject Ho
Liquid/Solid	1.525	40	1.318	22	60	1.125662	2.000297		Fail to Reject Ho
Matter & Energy Unit	1.375	40	3.182	22	60	-3.967177	2.000297		Reject Ho
Nucleon	1.400	40	2.318	22	60	-3.107012	2.000297		Reject Ho
Electron	1.725	40	1.909	22	60	-0.601410	2.000297		Fail to Reject Ho
Radioactivity	1.725	40	2.364	22	60	-1.181821	2.000297		Fail to Reject Ho
Atomic Unit	1.400	40	2.364	22	60	-3.055736	2.000297		Reject Ho
Bonding	1.450	40	4.227	22	60	-7.060604	2.000297		Reject Ho
Forces of Attraction	1.375	40	3.136	22	60	-4.993293	2.000297		Reject Ho
Formulas/Naming	1.750	40	3.455	22	60	-4.219814	2.000297		Reject Ho
Bonding Unit	1.625	40	2.727	22	60	-2.577791	2.000297		Reject Ho
Periodic Table	2.125	40	2.045	22	60	0.306582	2.000297		Fail to Reject Ho
Chemical Families	1.850	40	1.318	22	60	2.521860	2.000297		Reject Ho
Periodic Table Unit	1.700	40	1.818	22	60	-0.401808	2.000297		Fail to Reject Ho
Chem Math 1	1.800	40	3.091	22	60	-3.881052	2.000297		Reject Ho
Chem Math 2	1.750	40	2.273	22	60	-1.482596	2.000297		Fail to Reject Ho
Chem Math Unit	1.650	40	2.273	22	60	-2.180420	2.000297		Reject Ho
Kinetics & Equilibrium	2.200	40	3.227	22	60	-2.398159	2.000297		Reject Ho
delta G/ Ksp	1.974	40	1.591	22	60	1.472272	2.000297		Fail to Reject Ho
Kinetics Unit	1.825	40	2.727	22	60	-2.290572	2.000297		Reject Ho
Acids/Bases	1.650	40	1.682	22	60	-0.143493	2.000297		Fail to Reject Ho
Ka/pH	2.000	40	2.000	22	60	0.000000	2.000297		Fail to Reject Ho
Acids/Bases Unit	1.525	40	1.909	22	60	-1.110953	2.000297		Fail to Reject Ho
Redox	1.450	40	2.182	22	60	-2.287357	2.000297		Reject Ho
Electrochemistry	1.325	40	2.545	22	60	-3.557499	2.000297		Reject Ho
Redox Unit	1.650	40	1.955	22	60	-0.720732	2.000297		Fail to Reject Ho
Organic Molecule	1.500	40	2.909	22	60	-3.273268	2.000297		Reject Ho
Organic Reactions	1.500	40	1.636	22	60	-0.606215	2.000297		Fail to Reject Ho
Organic Unit	1.300	40	1.409	22	60	-0.315653	2.000297		Fail to Reject Ho

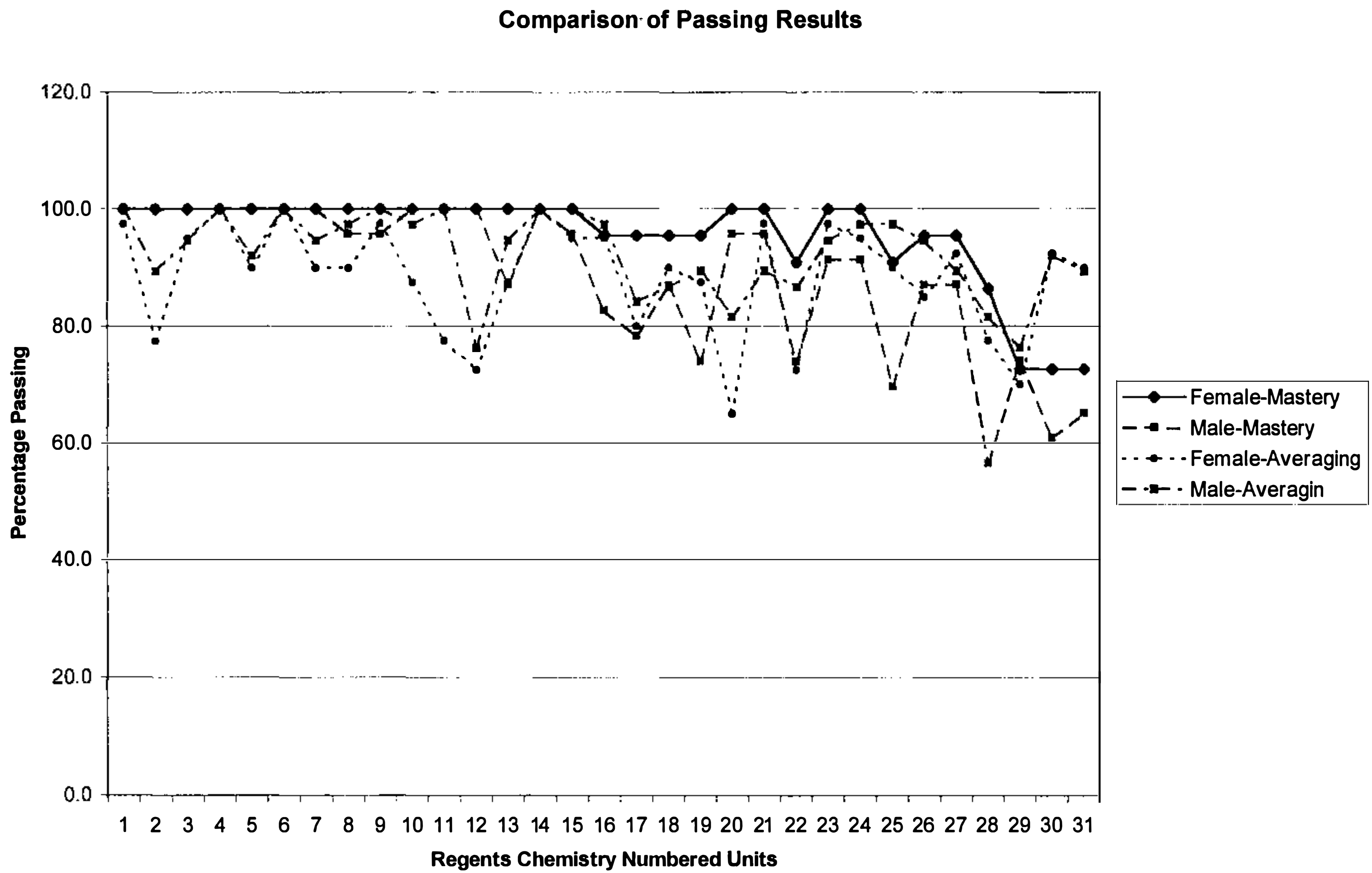
Appendix - Table A13
t-Test Results Comparing Average Trials Needed for Male Students Averaging and Mastery Testing Strategies

	Male Avg. Mean	No. of Observ.	Male Mast. Mean	No. of Observ.	df	t Stat	t critical		Reject or Fail to Reject Ho
Quiz/Test Given									
Background	1.657	38	1.435	23	59	1.143088	2.000997		Fail to Reject Ho
Matter & Energy	1.632	38	2.696	23	59	-4.072457	2.000997		**Reject Ho**
Gas	1.579	38	2.174	23	59	-2.341756	2.000997		**Reject Ho**
Liquid/Solid	1.289	38	1.391	23	59	-0.674037	2.000997		Fail to Reject Ho
Matter & Energy Unit	1.553	38	1.739	23	59	-0.585295	2.000997		Fail to Reject Ho
Nucleon	1.421	38	1.870	23	59	-2.015257	2.000997		**Reject Ho**
Electron	1.395	38	2.000	23	59	-2.462295	2.000997		**Reject Ho**
Radioactivity	1.553	38	1.957	23	59	-1.463867	2.000997		Fail to Reject Ho
Atomic Unit	1.421	38	2.435	23	59	-2.749477	2.000997		**Reject Ho**
Bonding	1.842	38	2.609	23	59	-2.342512	2.000997		**Reject Ho**
Forces of Attraction	1.605	38	2.826	23	59	-3.653610	2.000997		**Reject Ho**
Formulas/Naming	1.789	38	2.391	23	59	-1.560131	2.000997		Fail to Reject Ho
Bonding Unit	1.763	38	2.043	23	59	-0.792278	2.000997		Fail to Reject Ho
Periodic Table	1.974	38	1.826	23	59	0.441967	2.000997		Fail to Reject Ho
Chemical Families	1.947	38	1.522	23	59	1.793042	2.000997		Fail to Reject Ho
Periodic Table Unit	1.605	38	1.217	23	59	1.681270	2.000997		Fail to Reject Ho
Chem Math 1	1.789	38	5.957	23	59	-2.129390	2.000997		**Reject Ho**
Chem Math 2	1.684	38	1.913	23	59	-0.753158	2.000997		Fail to Reject Ho
Chem Math Unit	1.526	38	1.348	23	59	0.617231	2.000997		Fail to Reject Ho
Kinetics & Equilibrium	2.184	38	5.261	23	59	-1.573442	2.000997		Fail to Reject Ho
delta G/ Ksp	1.737	38	1.783	23	59	-0.149444	2.000997		Fail to Reject Ho
Kinetics Unit	1.684	38	1.652	23	59	0.092488	2.000997		Fail to Reject Ho
Acids/Bases	1.684	38	4.261	23	59	-1.305970	2.000997		Fail to Reject Ho
Ka/pH	1.868	38	1.348	23	59	2.406531	2.000997		**Reject Ho**
Acids/Bases Unit	1.289	38	1.478	23	59	-0.711263	2.000997		Fail to Reject Ho
Redox	1.368	38	2.043	23	59	-2.284721	2.000997		**Reject Ho**
Electrochemistry	1.500	38	2.478	23	59	-3.236330	2.000997		**Reject Ho**
Redox Unit	1.579	38	1.826	23	59	-0.517807	2.000997		Fail to Reject Ho
Organic Molecule	1.763	38	3.000	23	59	-4.333322	2.000997		**Reject Ho**
Organic Reactions	1.658	38	1.522	23	59	0.594827	2.000997		Fail to Reject Ho
Organic Unit	1.605	38	0.957	23	59	2.909246	2.000997		**Reject Ho**

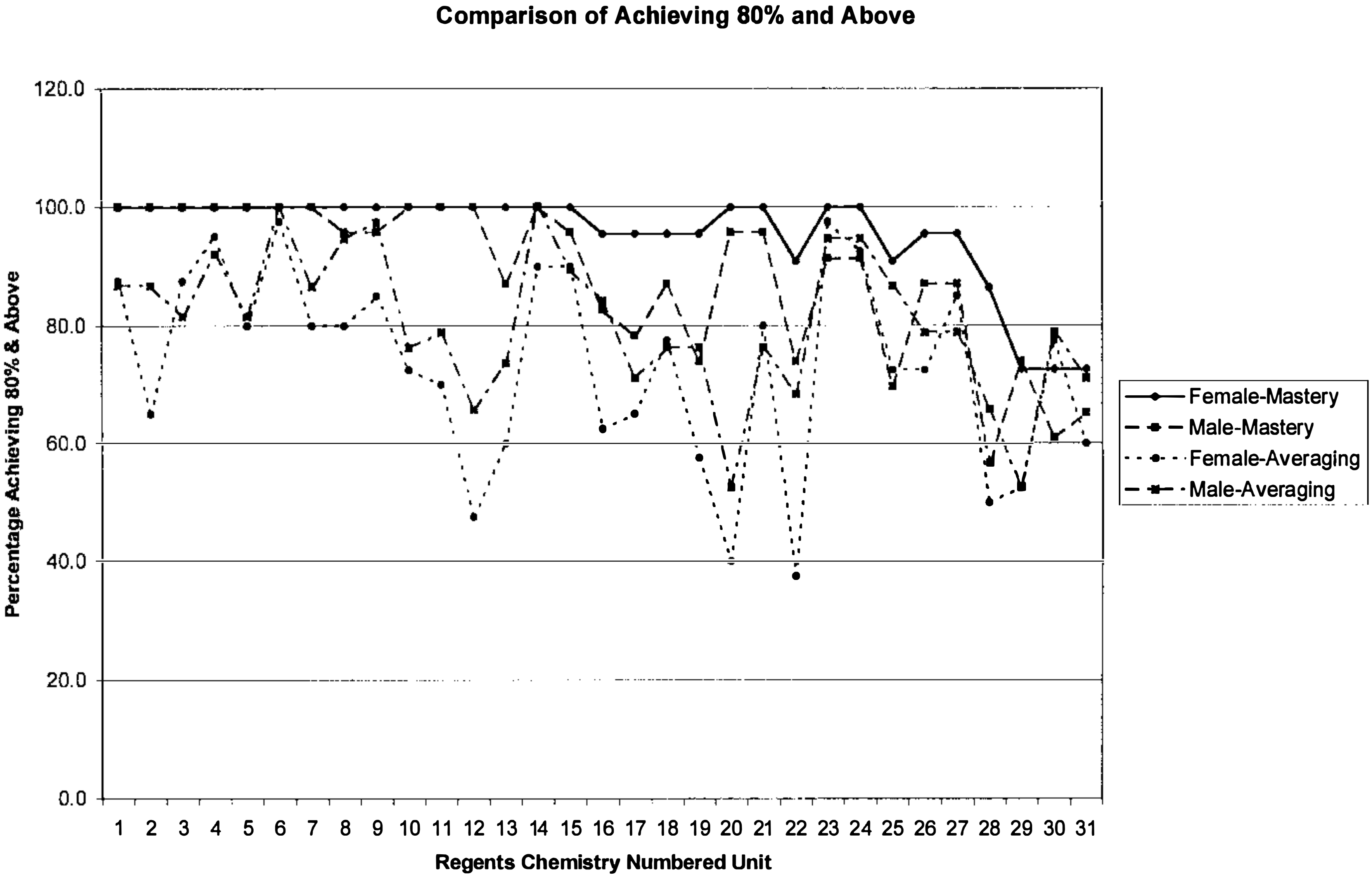
Appendix - Graph A1



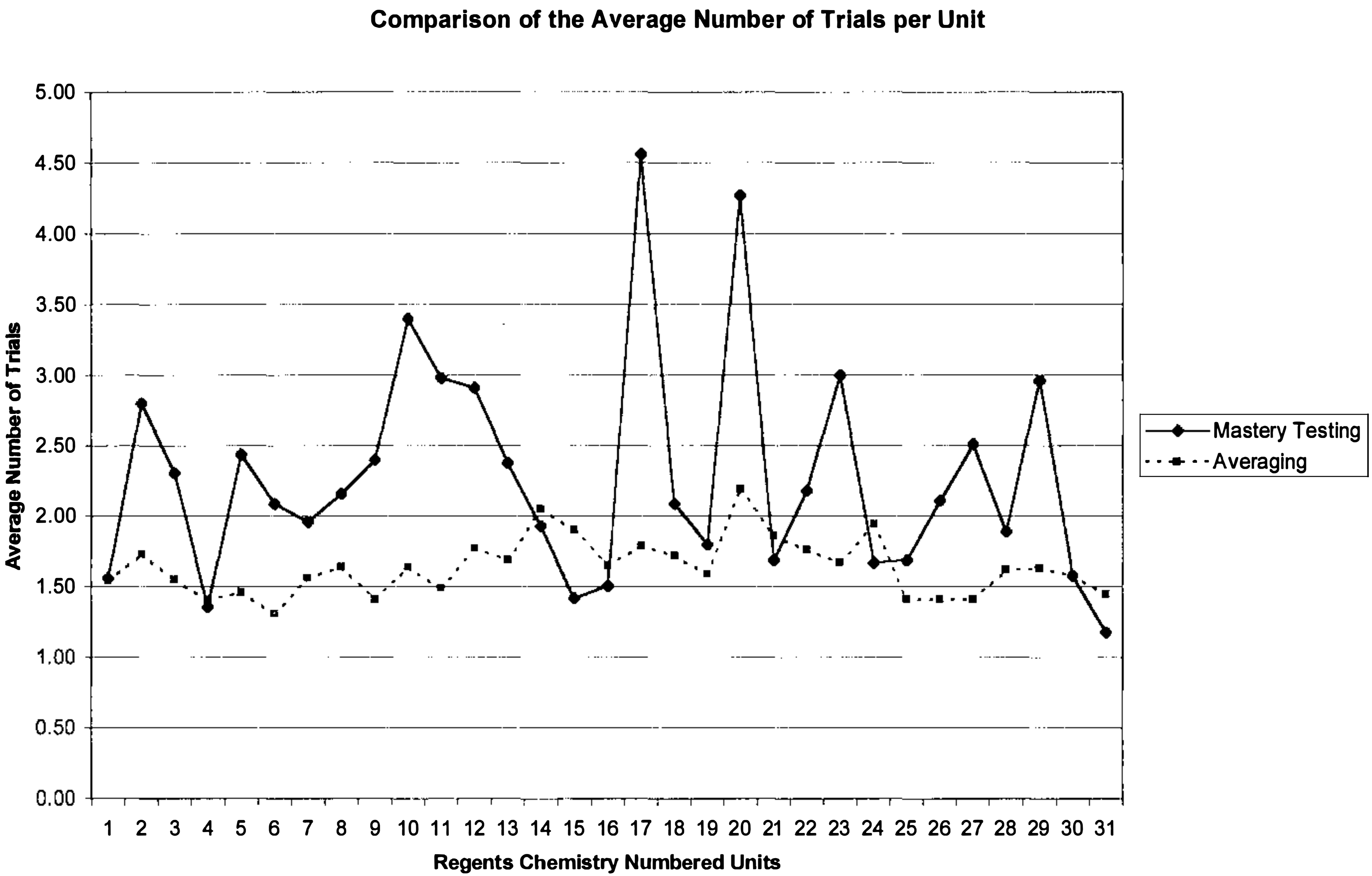
Appendix - Graph A2



Appendix - Graph A3



Appendix - Graph A4



Appendix - Graph A5