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# INVESTIGATING COMPUTER-BASED FORMATIVE ASSESSMENTS IN A MEDICAL TERMINOLOGY COURSE

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# INVESTIGATING COMPUTER-BASED FORMATIVE ASSESSMENTS IN A MEDICAL TERMINOLOGY COURSE

By

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# INVESTIGATING COMPUTER-BASED FORMATIVE ASSESSMENTS IN A MEDICAL TERMINOLOGY COURSE

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Research has been conducted on the effectiveness of formative assessments and on effectively teaching medical terminology; however, research had not been conducted on the use of formative assessments in a medical terminology course. A quantitative study was performed which captured data from a pretest, self-assessment, four module exams, and a final exam for 48 students to explore the effectiveness of formative assessments in an online medical terminology course. The students enrolled in the course were randomly divided into two groups and assigned a self-assessment for one of two modules of course content. Data indicate that the inclusion of self-assessment opportunities did not influence summative exam scores. However, there may have been a positive relationship between completing the self-assessment multiple times and the final exam score.

## Dedication

*To*

*My husband Tanner,*

*My son Tucker,*

*My mother Marian,*

*Dad and Mom #2, Tim and Debbie,*

*and*

*To the memory of my father, Jimmie.*

## Acknowledgement

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My family, I could not have achieved this goal without you cheering me on. I love you!

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# Chapter 1

# Introduction

## Context of the Study

Medical terminology is the language used to describe the human body and medical conditions; therefore, fluency in this language is important in all healthcare and medical professions. Healthcare professionals need to be confident in medical terminology so that they can effectively and accurately communicate with the medical staff, as well as act as a liaison between patients and medical staff (Brahler & Walker, 2008). Specifically, radiologic science professionals need to understand radiographic examination orders and diagnostic reports. They also need to describe patient conditions and history accurately and concisely to radiologists and other appropriate medical staff members.

While medical terminology is a common part of all healthcare and medical curricula, little emphasis is placed on the subject. Medical terminology, especially in the radiologic science professional curriculum, is often part of an introductory course where is it designed as a word-building self-study module. A review of 30 Texas radiography programs accredited by the Joint Review Committee on Education in Radiologic Technology showed that 10 have a separate medical terminology course, and six have medical terminology as a prerequisite for program acceptance. Nineteen programs include medical terminology as a topic in an introduction to radiography course. One

program did not identify either a medical terminology or introduction to radiography course.

When stand-alone terminology courses are offered, some programs use online course delivery while others utilize traditional face-to-face instruction. With either delivery method, the subject is usually placed in the first semester of the professional program. At that time, students are engaged with learning new ideas, theories, skills, and concepts related to the profession. Under these circumstances, terminology often receives short shrift. Many students learn the material haphazardly, if at all.

It has also been observed that the teacher plays a very minor, almost non-existent, role in the medical terminology course or module. Students are usually left to their own devices to complete course activities, often with little or no feedback. The only "feedback" students normally receive are summative assessment grades. This lack of teacher involvement can cause students to feel isolated and even frustrated (Culley, 2006), as well as leading to devaluation of this content. This is especially true for online courses in which there is usually no face-to-face time. It is easier to identify and solve problems face-to-face than with written word only (Culley, 2006).

A majority of courses are set up to only have summative evaluations. However, this can have a detrimental effect on student learning because students will focus on making the grade instead of learning the content. The inclusion of quality formative assessments would be expected to enhance learning (Gipps, 2005). Since students often view formative assessments as less important than summative assessments, relating the

vitality of formative assessments may present an instructional design challenge (Scott, MacLean, Marshall, & Van Asperen, 2008).

It is important to healthcare and medical professions to identify a learning method for medical terminology that is both feasible and effective. In this study, medical terminology is its own course and is taught via *Blackboard*© using a word-building, self-study approach. If administered properly, formative assessments may have a positive impact on student learning and success in a medical terminology course.

**Purpose of the Study**

This study explored the effectiveness of formative assessments in an online medical terminology course. The study did *not* compare the effectiveness of online formative assessments to pen-and-paper formative assessment, nor will it compare the effectiveness of proctored formative assessments to unproctored formative assessments

**Research Questions**

1. Being presented with the resource, do students take advantage of formative assessment opportunities in an online medical terminology course?
2. Do students who take advantage of the formative assessment opportunities score higher on module exams?
3. Do students who take advantage of the formative assessment opportunities score higher on the final exam?

**Research Hypotheses**

1. Higher-achieving students will access formative assessment opportunities more often than lower-achieving students.

2. Students who access the formative assessment opportunities on a consistent basis will score higher on module exams than those who do not.
3. Students who access the formative assessment opportunities on a consistent basis will score higher on the final exam than those who do not.

**Significance of the Study**

The available research on teaching and learning medical terminology either compares proctored versus unproctored assessments or online versus traditional assessments. This study was designed to fill the research void and address the issue of student use of formative assessments and their actual impact on student learning. This study did not solidify the role of formative assessment in an online medical terminology course.

# Chapter 2

# Literature Review

## Learning Medical Terminology

Medical terminology refers to specific terms and nomenclature used in the healthcare and medical professions. It is important that all healthcare professionals have a solid understanding of medical terms and how medical terms are built. Medical terminology is viewed as the foundation of any health or medical profession, as well as a prerequisite to the problem-solving and critical-thinking skills required in the health and medical professions (Brahler & Walker, 2008). While medical terminology is essential in medical and health professions, it is duly noted that it is often a difficult subject to master (Banay, 1948).

The difficulty of learning medical terminology stems from the terms' origin. While medical terms are largely based on the Greek language, some terms are also based on the French and Latin languages (Athanasiadis, 1997; Banay, 1948; LaFleur Brooks & LaFleur Brooks, 2010). This makes learning medical terminology similar to learning a second language (L2); and in some cases a third language for foreign or English as second language students. Also, the multiple origins allows for duplication of terms; requiring students to learn multiple medical terms for their English counterpart. For example, skin is translated into *cutane*, *derm*, and *dermat*, and the word part used depends on the context. Both *derm* and *dermat* are based on the Greek language, while *cutane* is Latin based (LeFleur Brooks & LeFleur Brooks, 2010). When referring to the

skin as an organ, the word root *dermat* is used: dermatologist, dermatology, dermatopathy, and dermatitis. *Derm* is often used when identifying an object's physical relation to the skin or appearance of the skin: epidermal, intradermal, hypodermic, xanthoderma, leukoderma, and melanoderma. It is common to use *cutane* when referring to the layers of the skin, or the tissue: subcutaneous, and percutaneous. *Derm*, *dermat*, and *cutane* all translate to skin, but each has specific uses. This can cause confusion in students new to medical terminology.

Medical documents usually contain medical terms that healthcare professionals must be able to define with precision. LaFleur Brooks and LaFleur Brooks (2010) pointed out that "prostate" and "prostrate" are often times used incorrectly, "a common error is to write or say prostrate, meaning to lie flat, instead of prostate" (p.151). Another common error is to misuse "ilium" and "ileum": ilium refers to a bone in the pelvis; ileum is part of the small bowel. Baumann, Steinmetzer, Karami, and Schafer (2009) stress that "oral communication has to be quick and precise" in the medical and healthcare setting (p. e460). For this to happen, students must have a solid understanding of medical terminology.

McGuire (2009) has identified three common ways in which medical terms are haphazardly taught: repeat encounters, inference meaning, and memorization. Repeat encounters occur when students learn whole medical terms by reading them in texts or hearing them in lectures. Emphasis is not placed on learning the terms encountered, rather on the subject matter at hand. This method relies on chance; chance that students learn the meaning and chance that they actually attend to learning the term. Inference learning results from students learning to decode the terms from repeated encounters.

This is different from repeated encounters because in this method students are expected to learn the word parts, not just the whole word. It is assumed that students will learn the word parts through persistent exposure to whole terms and without instruction to learn the word parts. Again, this method relies on chance learning. Memorization using a medical dictionary is the third common approach to learning medical terms. This rote memory approach puts great demand on cognitive capacities. The learning strategy is essentially always the same: rehearse, rehearse, rehearse. The clarity and simplicity of the description of this strategy belies the inherent difficulty in its application. Not only are students expected to memorize the spelling of the term, but also the lengthy definition provided in the medical dictionary. A more challenging aspect of this learning strategy is the number of terms in a medical dictionary. It is not effective to instruct a student to learn medical terminology by reading a medical dictionary.

These three methods do not recognize that motivation in learning is essential, human memory has a capacity, or that students learn by making connections and developing schemas (Clark, Nguyen, & Sweller, 2006; Shell et al., 2010). In the Unified Learning Model, Shell et al. (2010) identify motivation as essential to the learning process. If students are not motivated to allocate working memory to the task at hand, learning will not occur. Motivation can be increased if interest is sparked, "interest can play a significant role in directing students to attend to relevant instructional content" (p.129). The aforementioned methods fail to appropriately generate interest in learning medical terminology; which, in turn, causes students to dismiss learning the medical terms.

Based on the Cognitive Load Theory, there are three types of load that can be imposed: intrinsic, germane, and extraneous. The name of the theory, *Cognitive Load*, in itself implies that effort will be required to learn, and all types may be necessary. The key to achieving efficient learning is to minimize the total load in the instructional material such that it is within the learner's capability. Intrinsic load is related to the content of the instruction: The more difficult materials, those with greater number of productions to master, correlate with higher intrinsic loads. Through sequencing of the material and other scaffolding, intrinsic load usually can be managed. Germane load involves having students think and make connections. Germane load can lead to more efficient chunking. While it may have taken much effort to develop connections, the pay-off may be increased learning efficiency. Finally, extraneous load deals with outside influences or distractions. For example, having content in two sources such as two different screens or a book and a screen creates extraneous load. When detected, this load should be minimized and preferably eliminated.

As with the Cognitive Load Theory, the Unified Learning Model also recognizes that the human capacity is limited (Clark et al., 2006; Shell et al., 2010). In the repeat encounters and memorization methods, the focus is expected to be on both the lecture material or definitions and the medical terms. This requires the students to focus on two topics; however, human capacity does not allow for them to fully focus on two separate topics at once (Shell et al., 2010). Also, just looking at a medical dictionary could increase a student's extraneous load. They may become consumed by the presentation of the terms that they do not attend to learning the terms effectively.

Human capacity is directly affected by prior knowledge (Shell et al., 2010). In all of these methods, students are expected to attend to both the word parts and the whole word without any prior exposure and without explicit instruction. They are expected to make connections without any prior knowledge. The subject matter, in this case medical terminology, should be the focus of the lesson and not an incidental effect. While these methods are not effective for learning medical terminology, there are other methods that have shown positive results.

Karpicke (2009) and Karpicke and Blunt (2011) describe *retrieval learning*. In retrieval learning, students first study the material, and then they recall what they know on a free recall test. The students then repeat this process. Karpicke (2009) explored retrieval learning with foreign-language students and Karpicke and Blunt (2011) with science students. Both studies found that overall learning and long-term retention are greater with retrieval learning. Karpicke and Blunt (2011) explored this concept more and found that retrieval learning produced greater learning results than learning by concept mapping. Retrieval learning produced positive results in knowledge-based and inferential learning.

McGuire (2009) proposes a word part analysis approach, with an emphasis on encoding and decoding. McGuire (2009) defines decoding as breaking down medical terms and encoding as building medical terms from provided definitions. Schemas result from the mental classification or categorization of information resulting in decreased cognitive load (Sweller & Cooper, 1985). The result is a mental file cabinet of information. In this case, students will be taught prefixes, suffixes, and word roots separately. He recommends working on each word part for two- to three weeks each.

Students will develop mental files for each of the word parts that will help them in the decoding and encoding lessons at the end of the semester. This schedule allows adequate time for a detail study of the word parts and formative assessment opportunities before moving on to the more advanced topic of decoding and encoding.

For the more challenging encoding activities, McGuire (2009) suggests a scaffolding technique. Scaffolding results in learning because appropriate working memory can be allocated for learning what is necessary. The student is not stressed; intrinsic load is managed by spreading it out over several tasks rahter than concentrating it in one task. Scaffolding is a way to not only increase the student's participation in the process, but to increase his self-efficacy enough so that goal attainment is desirable and possible. The structuring and sequencing of material lowers intrinsic load, thus meeting cognitive capacity limits. Scaffolding usually includes feedback related to student performance. It is not necessarily corrective in nature but supportive and directive to help lead the student to correct performance. Ultimately, scaffolding should be faded out as student self-efficacy and knowledge increase.

In Yang's (2005) study of Taiwan nursing pre-professionals, high-level learners reported using the vocabulary section of the textbook, note taking during class, and using a bilingual dictionary as the top three strategies to learn medical terminology. This finding conflicts with McGuire's (2009) discussion of teaching medical terminology in a word part analysis approach. However, Yang (2005) also found that low-level learners reported their top three learning strategies as written repetition, verbal repetition, and asking classmates for meanings. In these instances, students are likely practicing rote memorization instead of learning the meanings of the word parts. While these strategies

do not attend to learning as effectively as those reported in high-level learners, they may be the only strategies low-level learners know how to use. Both McGuire (2009) and Yang (2005) stress that learning strategies should emphasize learning the meanings of the word parts versus learning all the terms. This would provide a greater chance of retention because these terms are not used in everyday life.

Brahler and Walker (2008) found that students who learned medical terminology using an illogical association mnemonic strategy had significant gains in learning compared to those who learned through rote memorization. This process entails students creating a visual diagram of a medical term and keyword mnemonic. For example, students learning the word root *gastr* will be given the keyword *gas truck*. Next they are instructed to draw a picture that represents both the medical term and the key word. In the *gastr* example, students might draw a gas truck with a stomach in place of the tank. Brahler and Walker (2008) also found that students who learned by the illogical association mnemonic strategy had an increase in retention of the material and deeper learning.

This illogical association or mnemonic strategy is not novel to learning language. Raugh and Atkinson (1974) conducted a study with university students learning Spanish words for the first time. They found keyword mnemonic effective in foreign-language curricula. They identified characteristics to increase the effectiveness of learning by this method: (a) the educator should provide the keyword, (b) students need to generate their own picture representations, and (c) keywords should be kept simple and at one or two syllables. In contrast to Brahler and Walker (2008), they found that students found picture representation too restrictive at times, preferring key phrases instead. Raugh and

Atkinson (1974) identified limitations of this learning strategy. Pronunciation may be hindered because of the use of keywords. They also note that retrieval of terms may be slowed because the student has to process the association. Pronunciation is important in medical terminology and the medical and health fields are fast paced; therefore, this method may not be best-suited for learning medical terminology.

All of the aforementioned methods of teaching and learning medical terminology have merit; however, no one method is consistently superior. The inclusion of formative assessments into the medical terminology course adds a unique feature and is indirectly supported by research by Karpicke (2009) and Karpicke and Blunt (2011) and directly by Shell et al. (2010). It allows the students to receive performance-related feedback in a non-threatening environment.

**Formative Assessment**

In his extensive review of literature on classroom assessment techniques, Crooks (1988, p. 441) found that "[the] learning strategies students adopt are powerful predictors of educational outcomes, so that expertise in the selection and application of learning strategies is an important education outcome." Assessments not only influence how students learn the content at hand, but they can also alter the student's epistemological view.

While most research on formative assessment looks at content quizzes, there are other types of formative assessments that can help students learn: crossword puzzles, question and answer sessions, multi-strategy formative assessment modules, and homework assignments (Peat, Franklin, Devlin, & Charles, 2005; Wang, Wang, Wang, &

Huang, 2006). Students found crosswords to not only be fun and engaging but challenging as well (Peat et al., 2005). Wang et al.'s (2006) study on formative assessment modules included six different strategies:

- Repeat the test- Students are allowed to take the same quiz multiple times. After successfully answering a question three times, that question will be automatically discarded from the quiz;
- Provide with no answer- Upon completing a quiz, students are only provided with incorrect answers. They then have the opportunity to research the correct answers on their own;
- Ask questions- Students can send questions to the teacher via email;
- Query scores- Students have access to test statistics;
- Monitor answering history- Students can view their answering history for quiz items; and
- All pass and then reward- Upon making a 100 on a quiz, students are rewarded with a flash animation.

Students had positive attitudes regarding all six formative assessment strategies, but were more satisfied with asking questions via email and the all pass and reward strategy (Wang et al., 2006). They also found that student achievement increased with the use of formative assessment strategies. They surmise that providing multiple avenues of formative assessment will enhance learning.

Over the years, formative assessments have been found to be effective learning strategies. Zakrzewski and Bull (1998) found that biology students who completed

modules with formative assessment opportunities scored higher in the course than students who completed the same modules but without the formative assessment activities. To further substantiate this claim, there was not a grade change in the module lacking formative assessment opportunities. After the inclusion of formative assessments in course modules, the first-time pass rate increased by 7.5%.

Olson and McDonald (2004) also had similar results in their study on first-year dental students. While not statistically significant, students who completed the formative assessments had higher final exam scores than those who did not. Students also felt that the formative assessments better prepared them: "The use of the electronic formative (practice) exam questions helped me prepare more effectively for my biweekly exam" (p.657).

Both Kibble (2007) and Kolistsky (2008) recommend removing any point or grade value from quiz-based formative assessments. While Kibble (2007) found that medical school students in a medical physiology course perform significantly better on summative assessments, inappropriate use of formative assessment increased with the introduction of incentives. He found that students who performed with 100% accuracy on the formative assessments, sometimes performed poorly on the associated summative assessment. In 2008, Kolistsky also saw similar results and proposed that "students will only take the quizlets until they get the credit they desire" (p.5). Furthermore, he states that formative assessment lose their meaning and become more summative in nature when incentives are introduced. In addition to knowledge assessment, Kolistsky also identifies that practicing with the timed formative assessments is good for the students;

and the number of times a student takes the formative assessments correlates with summative assessment grades.

Although formative assessments are often part of teaching and learning, they often are underutilized and/or misused. They should serve not only as a way to identify problem areas but to also provide quality feedback on strengthening the identified areas (Black & William, 1998; Gipps, 2005; Pellegrino, 2001; William & Black, 1996). Specifically, formative assessments should be used to identify gaps in learning and suggest ways to decrease the gaps (Black & William, 1998). Formative assessments should provide the students with a low-stakes, non-threatening learning opportunity to build on prior knowledge and to facilitate higher learning (Cliff et al., 2008; Gipps, 2005; Olson & McDonald, 2004; Pellegrino, 2001; Scott et al., 2008). Gipps (2005) further defined formative assessments as a method to improve and increase student learning. She stressed that they should be both motivational and substantive.

When designing a formative assessment tool, the specific purpose, objective, and learning goal must be taken into consideration (Pellegrino, 2001). It should not be thrown together haphazardly as it can have a great and positive impact on student learning and retention, if designed properly (Cliff et al., 2008; Crooks, 1988; Kibble, 2007). William and Black (1996) suggested that students be given several opportunities to assess their knowledge before a summative evaluation. This helps decrease any “false-positive” situations (defined as a situation in which it is assumed students know something when they actually do not). Not only should there be a multitude of assessment opportunities but also a variety (Pellegrino, 2001). A variety of formative assessments not only provides a multiple learning experiences for the students; it also decreases the monotony

of learning (Black & William, 1998). Black and William (1998), however, stress that the key to both frequency and variety of assessments is quality. Several low quality formative assessment opportunities are less effective than few high quality assessments. Pellegrino (2001) agreed with this notion, stating that student success should be gauged from a variety of assessments, not a single score.

Allen, Ort, and Schmidt (2009) identify the following criteria for formative assessment activities: (a) goals, (b) criteria, (c) support, (d) process and product, and (e) feedback. First, goals need to be indentified and directly related to the course content. Second, performance indicators and criteria need to be adequately addressed. For example, this can be done in the form of a rubric. Third, students need opportunities to assess their current level of knowledge. Fourth, a balance between student outcome and process needs to be maintained. Finally, students need to receive performance-based feedback so that they know what they need to improve.

As with Allen, Ort, and Schmidt (2009), Shell et al. (2010) also stress the importance of goal identification, practice, and goal-based feedback. They further the notion by highlighting the importance of goals: "The key feature of formative assessment is that it provides teachers with an opportunity to assess student progress toward the goal together with an opportunity to provide students with feedback about their progress including recommendations for improvement" (p.142). Students should be given many opportunities to practice the assessment and should be provided with adequate feedback to help with goal attainment. These features can help with long-term retention of the content at hand. Shell et al. (2010) identify feedback quality as vital to the success of

formative assessments. Feedback should be substantial and meaningful, as to require the student to reflect on his performance.

Black and William (1998) asserted that there are minimal negative outcomes of formative assessment, but the level of positive outcomes depends on numerous factors. First, students must actually be motivated to use the assessment and the feedback for the intended purpose. This requires student understanding of the tool, which is accomplished by explaining how the assessment reaches the stated learning goals (Pellegrino, 2001). Kibble (2007) found that formative assessments can be misused if incentives are associated with them. He suggested that expectations regarding "help" be outlined. Students may also view formative assessment as less important than summative assessment; therefore student buy-in is extremely important (Pellegrino, 2001; Scott et al., 2008).

Second, students must not only actively participate in the learning process, but see this as a learning opportunity (Black & William, 1998). This requires the assessment to be truly formative, with no visible or hidden summative agenda. This secondary agenda could also lead to misuse of the tool by students. It is also emphasized that success be based on effort, not ability or teacher perception (Black & William, 1998).

Third, educators may not be using these assessments for their authentic purpose, which should be student-centered and a learning experience for the students (Black & William, 1998; Gipps, 2005; Pellegrino, 2001). This usually occurs because of a misunderstanding and lack of training on formative assessment, and possibly fear. Using formative assessments as the core part of teaching requires a major change in pedagogy.

Lastly, as with any effective teaching strategy, formative assessments must be based on a cognitive theory (Black & William, 1998; Pellegrino, 2001). Once educators know how students learn, then the right assessments can be developed to gauge and evaluate student learning. Pellegrino (2001) asserted that, "if we fail to take into account how they know things, we are very likely to fail in instruction" (p.49). Scott et al. (2008) also emphasized that formative assessment should help build on students' prior knowledge.

Retrieval learning can also explain why formative assessments work. Students most likely practice once and then test themselves as a method for learning; they do not practice retrieval learning (Karpicke, 2009). Students do not continue to study information once they feel they know it. This can lead to poor learning and decreases retention (Karpicke, 2009). Formative assessments can force students to continually retrieve information. This is successful because it causes memory to change; it causes the learner to reconstruct knowledge. When memory is changed or knowledge is reconstructed, learning occurs.

**Computer Based Formative Assessment**

Wellman (2005) asserted that computer based learning provides students the opportunity for "ongoing, real-time assessment" of what they have learned (p.20). This assertion matches what research suggests should be the core characteristic of formative assessment. It also allows students the immediate opportunity to reflect on their learning and to identify, along with feedback from the instructor, areas of misunderstanding and weakness. The incorporation of self-assessment into the learning content can be fairly seamless (Gipps, 2005; Wellman, 2005). While Wellman (2005) also pointed out that this

environment allows for testing to become part of the learning process, it is important to keep formative assessments true to their purpose. When these assessments become more summative, their effectiveness decreases. However, Russell and Haney (2000) point out that students should be tested in the same format as they learn. This has specific implications in the study of radiologic science because students will have to complete a computer-based national registry examination upon completing the program.
"... Feedback from assessment could be automated, while maintaining quality in assessment, it could certainly be a powerful learning tool" (Gipps, 2005, p.175).

Both observation and research show many advantages of using computer-based assessments: time management, assessment control, and data analysis (Campton, 2004.; Gipps, 2005; Hui, Hu, Clark, Tam, & Milton, 2008; Lowry, 2005). Assessment questions can be typed into a text document and uploaded into the appropriate course management system via *Respondus*©. This process takes only a matter of minutes and is relatively easy and straightforward. While questions can be created with the *Respondus* program, it is not as easily accomplished as uploading a text document. Once the questions are in the appropriate course management system, such as *Blackboard*©, assessments can be created to include either a set of questions or a random selection of questions. Assessments can then be modified as to their allotted time, availability, attempts, etc. Again, this process takes just a few minutes. The random selection of questions allows for multiple versions of the same test to be completed. The database of questions can be as large or as small as necessary. Another advantage is to have the same question bank for formative assessments, self-assessments, and summative assessments. This helps increase question format familiarity (Lowry, 2005).

Once the assessment is completed by the student, grading is automatic. Questions can then be reviewed either by student view or question view. The student view allows for identification of answering patterns. If the assessment has a short-answer or essay component, the question view would be beneficial to grade all the submissions for a question at one time. Time statistics can also be viewed for each student. This allows identification of problem questions, or questions that took the longest to answer. This information can only be provided if the assessment is set to be delivered one question at a time.

Data analysis is provided instantly in *Blackboard* and contains several statistical values. The percent answering correctly in the whole group, upper 25%, and lower 25% are provided, as well as the discrimination, mean, median, and standard deviation values. It is also possible to compare the scores and statistics on two graded assessments. This tool would be useful for comparing pre- and post-test scores. The data can also be downloaded as a .csv file for further analysis if needed. This would be helpful when analyzing data from two sections of the same course as one set of data. Data analysis can also be completed using *Respondus*. This method puts everything in a single file, including a copy of each question and the associated response summary, grade distribution summary, and standard statistics. Both methods provide instructors with different display formats of the same information.

While the above represent administrative advantages, there are student learning advantages as well (Angus & Watson, 2009; Kibble, 2007; Lowry, 2005; Peat et al., 2005; Zakrewski & Bull, 1998). Using computer-based formative assessments, students can receive automated feedback and guidance instantaneously. Angus and Watson (2009)

found that low-achieving students were less likely to attempt the formative assessments voluntarily. Lowry (2005) also pointed out that instant feedback makes students more comfortable with taking computer based assessment in general, which may decrease anxiety when taking computer based summative assessments. Zakrewski and Bull (1998) also showed that test anxiety decreased with the inclusion of computer-based formative assessments. This is especially important in radiologic science programs and other healthcare and medical professional programs because many of the national examinations are computer based. In their study on computer-based formative assessments, Ricketts and Wilks (2002) found that students performed better on assessments when the questions were presented one at a time.

# Chapter 3

# Methods and Procedures

## Participants

The participants were students enrolled in the researcher's online medical terminology courses during the fall 2011 semester. A power analysis using G*Power computer program (Faul, Erdelder, Lang, & Buchner, 2007) indicated that a total sample of 34 people would be needed to detect a medium effect size ($\eta^2 = 0.25$) with 0.80 power using an independent samples t-test between means with alpha at .05.

There was a potential of 71 participants for the fall 2011 semester. This course is open to the university community; students from any major may take the course. Students include both on-campus and distance education students.

A pilot study was completed Summer 2011, with a potential of 30 students. The course instructor for Summer 2011 was different than the researcher. The purpose of the pilot study was to ensure all course releases were correctly configured.

## Institutional Review Board Procedures

Both the Institutional Review Board at the University of Nebraska-Lincoln (IRB# 20110211470 EX) and the Human Subjects Review at Midwestern State University (# 11010704) approved this study.

**Setting**

The study was conducted at a public, liberal arts university in the Midwest. Both sections of the medical terminology course were identical and delivered using Blackboard©. The two sections of the course were set-up identically and had the same grade criteria. The course was originally part of a 2-credit hour Introduction to Radiography course, which recently was separated into two 1-credit hour courses: Introduction to Radiologic Sciences and Radiologic Science Medical Terminology. Whereas the original course was taken during the first semester in the program, these two courses are now prerequisites for program admission. The change was made to provide students the opportunity to lessen their academic course load during their first semester in the program and to provide them with basic knowledge that is necessary to successfully complete the program.

The 12 lessons (chapters) of the textbooks were combined to form three modules of instruction. Module 1 contained introductory information plus a lesson on the respiratory system. Module 2 contained lessons on the urinary; reproductive; cardiovascular and lymphatic; and digestive systems. Module 3 covered the eye, ear, and plural endings; musculoskeletal; nervous; and endocrine systems. Additional information specific to radiologic technology was incorporated into a fourth module. Each module contained a table of contents with instructions and content links (see Figure 3.1). Other learning tools included slightly modified *PowerPoint* presentations provided by the textbook publisher and a student CD also provided by the textbook publisher.


Figure 3.1: Sample module table of contents

All participants were required to take a pretest to assess their beginning knowledge of the subject matter. The pretest was unproctored and contained 36 multiple-choice questions, sampling the terms that were to be learned throughout the course. The terms were taken from modules 2 and 3, as these chapters highlighted the bulk of medical terminology. The pretest contained four listening and spelling questions. The pretest questions came from a set of pretest questions provided by the textbook publisher and spelling questions developed by the instructor. Each participant received a pretest with identical questions, and had 45 minutes to complete the assessment. Completion of the pretest was required for the course modules to become available; however, the pretest did

not count towards the students' final grade. Pretest results were not released to the students.

The first three modules were assessed using a 50-question module summative exam, consisting of multiple-choice and spelling questions. Each module exam contained 11 or 12 questions from each textbook chapter and 5 spelling questions. The multiple-choice questions came from the textbook publisher provided test bank, and the spelling questions were created by the course instructor. Students were directed to play an audio clip for each spelling question. Module 4 contained a 45-question multiple-choice and 5-question spelling test. The multiple-choice questions were retrieved from a radiography test bank provided by the textbook publisher. The spelling questions were created by the course instructor. Upon completion of the module summative exams and after the availability period had ended, students received results showing the question text with the students' response and the correct answer. They also received their total score for the exam; feedback for each question was not provided, however. The summative exams for module 2 and module 3 were identical for each participant.

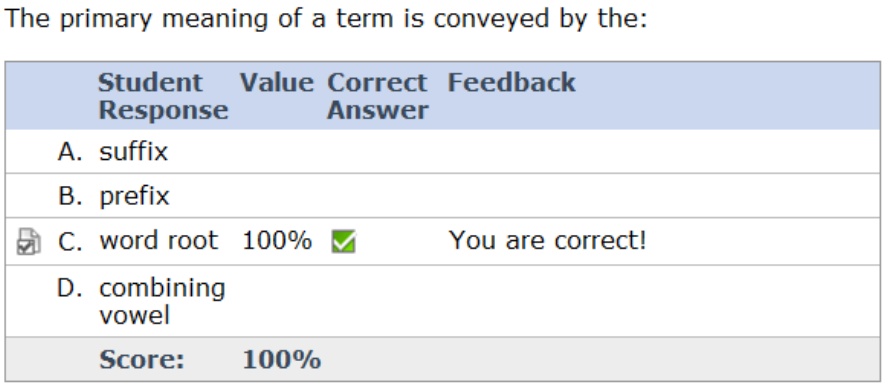
Students also completed a discussion activity and summative examination for each module. There was a two-part final exam at the end of the course.

**Treatment**

This study sought to identify the impact of formative assessments in a medical terminology course on student achievement. The medical terminology course was selected for this study because it had been observed that students exert the least amount

of effort in the course. It was originally a long self-study module within an introductory course.

For modules 2 and 3 there were randomly-generated self-assessment quizzes which students could complete an unlimited number of times before attempting the corresponding module exam. Each self-assessment contained 25 questions (5 or 6 questions from each chapter and 2 spelling questions) randomly drawn from the same database of questions as the summative exams. Students had 30 minutes to complete each self-assessment. Corrective feedback (Figures 3.2-3.5) was attached to the questions and delivered to the students immediately upon submission of the self-assessment. Students received feedback based on the answer they selected. All assessments contained recall and application-level questions. All self-assessments were similar but not identical for each student. Random generation of the questions and random order of the answer choices were enabled to discourage students from trying to memorize specific questions. The module self-assessments were the treatment.


The primary meaning of a term is conveyed by the:

| | Student Response | Value | Correct Answer | Feedback |
|---|---|---|---|---|
| A. | suffix | | | |
| B. | prefix | | | |
| C. | word root | 100% | ✓ | You are correct! |
| D. | combining vowel | | | |
| | Score: | 100% | | |

Figure 3.2: Sample feedback - Correct answer

The primary meaning of a term is conveyed by the:

| | Student Response | Value | Correct Answer | Feedback |
|---|---|---|---|---|
| A. | suffix | 0% | | attached to the end of the word root and provides additional information |
| B. | prefix | | | |
| C. | word root | | ✓ | |
| D. | combining vowel | | | |
| | **Score:** | **0%** | | |

Figure 3.3: Sample feedback - Incorrect answer

The primary meaning of a term is conveyed by the:

| | Student Response | Value | Correct Answer | Feedback |
|---|---|---|---|---|
| A. | suffix | | | |
| B. | prefix | 0% | | attached to the beginning of the word root and provides additional information |
| C. | word root | | ✓ | |
| D. | combining vowel | | | |
| | **Score:** | **0%** | | |

Figure 3.4: Sample feedback - Incorrect answer

The primary meaning of a term is conveyed by the:

| | Student Response | Value | Correct Answer | Feedback |
|---|---|---|---|---|
| | A. suffix | | | |
| | B. prefix | | | |
| | C. word root | | ☑ | |
| | D. combining vowel | 0% | | A vowel placed between two word roots and between a word root and a suffix; eases pronunciation |
| | **Score:** | **0%** | | |

Figure 3.5: Sample feedback - Incorrect answer

The placebo for the study was an instructor-created word puzzles. The word puzzles was created with *StudyMate*© puzzle generator and integrated into *Blackboard*© as a Sharable Content Object Reference Model (SCORM) module. SCORM refers to a framework for creating instructional tools so that they can be easily integrated into an online course management system (Lambert, 2007). It is not the actual learning tool, rather the method in which the learning tool was created. See Figure 3.6 for an example.


Figure 3.6: Sample word puzzle

**Procedure and Design**

Completion of the self-assessments was required as the summative and formative assessment activities were course requirements. Students received credit for 4% of their overall course grade for completing the activities. Below is a chart describing how the course grade was calculated.

| Course Activity | Percentage |
|---|---|
| Module Pronunciation Activities | 20% |
| Module Self-Assessment Activities | 4% |
| Module Exams | 40% |
| Two-Part Final Exam | 36% |

Figure 3.7: Course evaluation

Upon completion of the pretest, participants were assigned a number and then randomly assigned to one of two groups (A or B). The pretest scores were used to determine the equivalence of the two groups. The Blackboard© selective release function assisted with course management.

For modules 1 and 4, no students received the treatment. For module 2, Group A received the treatment and Group B received a placebo (Figures 3.6 & 3.7). For module 3, Group A received the placebo and Group B received the treatment. Participants had access to the activities associated with their group. Participants were required to complete the activities in order for the summative exams to become available. Participants were able to complete the self-assessment as many times as they wanted, but were required to complete it at least one time. Participants had to try the crossword puzzle once. Although the practice assessments during treatment differed, the summative exams for module 2 and for module 3 had identical questions for each student.

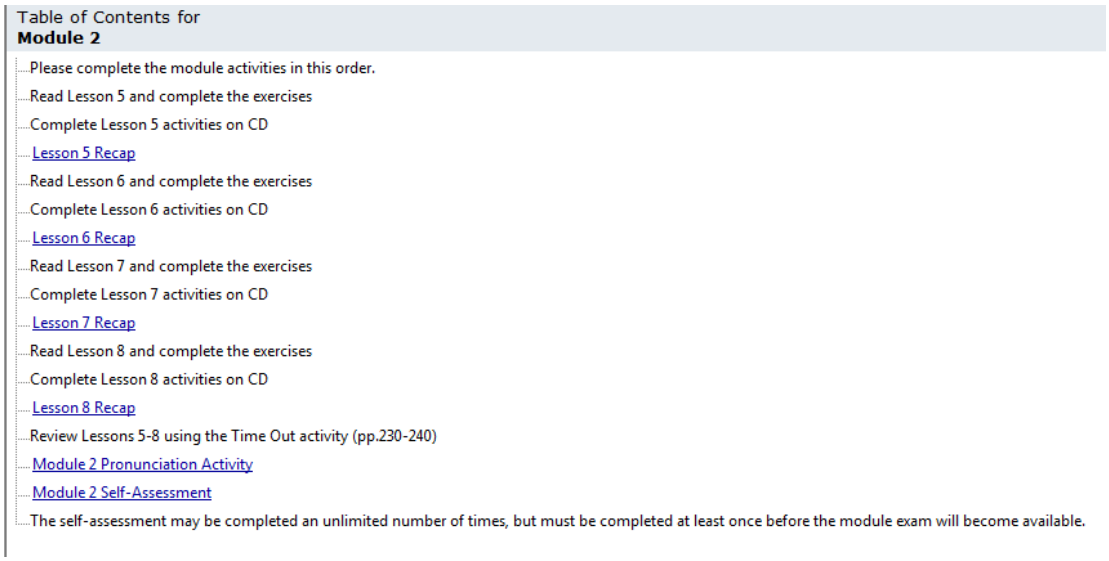



Figure 3.8: Sample table of contents for treatment group

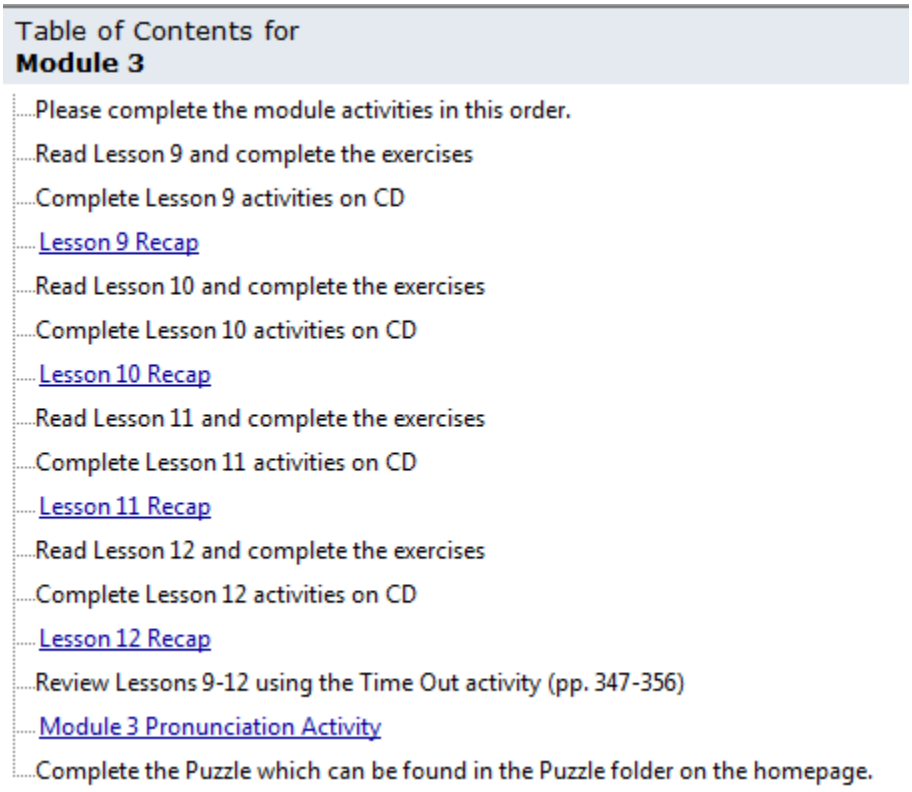



Figure 3.9: Sample table of contents for placebo group

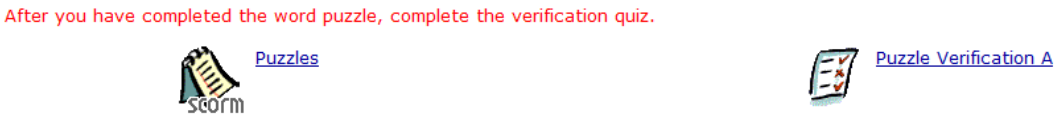



Figure 3.10: Contents of "Puzzle" folder

All students had to take two final exams. The first final exam was a spelling exam containing 25 questions, which students had to take using their own computer. This exam contained six questions each from modules 1 - 3 and seven questions from module 4. The second final exam was proctored and comprehensive over all chapters and the radiology supplement. It contained 18 to 20 multiple-choice questions from each of the modules. The questions on the proctored, final exam were identical for all students. The part of the proctored, final exam pertaining to modules 2 and 3 were the same questions as asked in the pretest.

Data collected from each participant included the pretest score, module 2 exam score, module 3 exam score, the final exam score, the date on which self-assessment(s) and the summative assessment was completed, and course grade. Only the multiple-choice questions were used for analysis; the spelling questions were omitted. Student learning was assessed using the module exams scores and the module 2 and 3 portions of the final exam score. Data pertaining to the number of attempts at the self-assessment were also collected.

**Data Analysis**

Data were analyzed using *IBM© SPSS© Statistics version 19.0*. Independent samples t-tests were calculated for each module exam and the final exam. An alpha level of 0.05 was used for all statistical tests.

# Chapter 4

# Results

## Introduction

This study investigated the effectiveness of formative assessment opportunities in an online medical terminology course and whether or not students utilized this learning aid. The purpose of the study was to investigate the short- and long-term effect of formative assessments.

All students were randomly placed in one of two groups, A or B. Students in Group A received the treatment for module 2, which was a randomly-generated self-assessment containing 25 questions. Upon submitting the self-assessment students received the results of their submission with feedback based on their answers. Students in Group B were given a placebo for module 2. The placebo was an unrelated word puzzle. Each student had to complete his assigned activity, treatment or placebo, before the module 2 exam could become available to him. For module 3, Group B received the treatment and Group A received the placebo. No group received either treatment or placebo for module 1 or module 4.

Seventy-one students were enrolled in the two sections of the course. Fourteen students opted out of the study, and two repeating students were dropped from the study. Additionally, three students from each group were dropped because of non-completion of the exams or self-assessment. The total number of active participants was 48. Group A had 23 participants, while Group B had 25 participants.

## Bonferroni Adjustment

Independent samples t-tests were conducted. Because 37 independent samples t-tests were run, a Bonferroni adjustment required an alpha level of 0.001 (i.e., 0.05/37) to be used on all statistical tests. This adjustment was made to decrease the chance of Type I Errors to occur (Huck, 2012).

## Equality of Groups

All students had to complete a pretest to gain access to the course. Refer to Table 4.1 for a summary of means for the pretest data. Results are provided for all students, and also subdivided into Group A and Group B. Results are also provided for the overall pretest score, and then further subdivided into module 2 questions and module 3 questions. Results on the time each group spent on the pretest (time on task) are also provided in Table 4.1.

Table 4.1: Summary of Means for Pretest

| **Pretest Scores** | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|
| ***All Questions*** | | | | |
| All Students | 48 | 60.12 | 17.18 | 2.48 |
| Group A | 23 | 59.54 | 14.30 | 2.98 |
| Group B | 25 | 60.66 | 19.75 | 3.95 |
| | | | | |
| ***Module 2 Questions*** | | | | |
| All Students | 48 | 61.46 | 21.57 | 3.11 |
| Group A | 23 | 58.94 | 19.37 | 4.04 |
| Group B | 25 | 63.78 | 23.58 | 4.72 |
| | | | | |
| ***Module 3 Questions*** | | | | |
| All Students | 48 | 59.03 | 15.99 | 2.31 |
| Group A | 23 | 59.18 | 11.44 | 2.38 |
| Group B | 25 | 58.89 | 19.51 | 3.90 |
| | | | | |
| ***Time on Task*** | | | | |
| All Students | 48 | 0:22:27 | 11:46.40 | 01:41.90 |
| Group A | 23 | 0:21:41 | 11:01.60 | 02:17.90 |
| Group B | 25 | 0:23:09 | 12:36.40 | 02:31.30 |

The overall average on the multiple-choice section of the pretest was 60.12 (SD = 17.18). The mean score for Group A was 59.54 (SD = 14.30) and the mean for Group B was 60.67 (SD = 19.75). For module 2 questions in the pretest, Group A had a mean score of 58.94 (SD = 19.37) and Group B had a mean of 63.78 (SD = 23.58). For module 3 questions in the pretest, Group A had a mean score of 59.18 (SD = 11.44) and Group B had a mean of 58.89 (SD = 19.51).

The overall average time spent on the pretest was 22:43 minutes (SD = 11:45). The mean time on task for Group A was 21:41 (SD = 11:01) and the mean for Group B was 23:42 (SD = 12:33).

Levene's Test for Equality of Variances was calculated on the overall pretest scores, module 2 questions, module 3 questions, and time on task and was not statistically significant (see Table 4.2). Therefore, the hypothesis that the sample is homogenous in variance is not rejected.

Table 4.2: Levene's Test for Equality of Variances for Pretest

| | | F | Sig. |
|---|---|---|---|
| **All Questions** | Equal variances assumed | 3.50 | 0.07 |
| **Module 2 Questions** | Equal variances assumed | 1.76 | 0.19 |
| **Module 3 Questions** | Equal variances assumed | 8.08 | 0.01 |
| **Time on Task** | Equal variances assumed | 0.25 | 0.62 |

Table 4.3 provides complete results of the independent samples t-tests for the pretest data: overall score on pretest, module 2 questions, module 3 questions, and time spent on pretest.

Table 4.3: Independent Samples T-Test for Pretest

| | | Independent Samples T-Test | | | |
|---|---|---|---|---|---|
| | | t | df | **Sig. (2-tailed)** | **Mean Difference** |
| **All Questions** | Equal variances assumed | -0.22 | 46 | 0.82 | -1.12 |
| **Module 2 Questions** | Equal variances assumed | -0.77 | 46 | 0.44 | -4.84 |
| **Module 3 Questions** | Equal variances assumed | 0.06 | 46 | 0.95 | 0.29 |
| **Time on Task** | Equal variances assumed | -0.42 | 46 | 0.67 | -00:01:27.21 |

An independent sample t-test was conducted on all sets of questions and time on task. The differences were not statistically significant:

- All questions: $t(46) = -0.22$, $p = 0.82$;
- Module 2 questions: $t(46) = -0.77$, $p = 0.44$;
- Module 3 questions: $t(46) = 0.06$, $p = 0.95$; and
- Time on task: $t(46) = -0.42$, $p = 0.67$.

## Statistical Analysis for Research Questions

**Research question 1.** Being presented with the resource, do students take advantage of formative assessment opportunities in an online medical terminology course? The hypothesis for this research question argued that higher-achieving students will access formative assessment opportunities more often than lower-achieving students.

Higher-achieving students are defined as those who receive a course letter grade of "A." The course investigated in this student utilizes a modified 10-point scale to match the passing score required on the national radiography certification examination.

The modified grade scale is as follows: A = 89.5-100; B = 79.5-89.4; C = 74.5-79.4; D = 64.5-74.4; F = 0-64.4. A letter grade of "C" is required in the course for consideration in admittance into the radiography program; however, a letter grade of "D" is considered passing by the university.

Refer to Table 4.4 for complete results of overall course grade data. Overall course means are provided for all students, and then subdivided into Group A and Group B. Results from Levene's Test for Equality of Variances are provided and are not statistically significant. Further, the independent samples t-test result is also not statistically significant: $t(46) = 1.35$, $p = 0.18$.

Table 4.4: Complete Results for Overall Course Grade Data

| **Course Grade** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 82.17 | 8.06 | 1.16 |
| | ***Group A*** | 23 | 83.80 | 7.50 | 1.47 |
| | ***Group B*** | 25 | 80.67 | 8.77 | 1.75 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 0.50 | 0.48 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 1.35 | 46 | 0.18 | 3.12 |

All students had to take their assigned self-assessment at least one time before the associated module exam would appear. Students in Group A were assigned the self-assessment for module 2. Four students completed the activity a second time, and one student completed it a third time. Students in Group B were assigned the self-assessment

for module 3. One student completed the assessment a second time, and no student completed it a third time.

Refer to Table 4.5 for complete results on letter grade comparison to number of self-assessments completed. Students with a course average of A (n = 10) completed their associated self-assessment an average of 1.10 times (SD = 0.57), while students who did not earn a course grade of A (n = 38) completed the self-assessment an average of 1.08 times (SD = 0.27). The difference was not statistically significant: t(46) = 0.17, p = 0.87.

Table 4.5: Complete Results for Letter Grade Comparison to Number of Self-Assessments Completed

| **Letter Grade Comparison to Number of Self-Assessments Completed** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 1.10 | 0.31 | 0.05 |
| | **> = *89.50*** | 10 | 1.10 | 0.57 | 0.18 |
| | **< *89.50*** | 38 | 1.08 | 0.27 | 0.04 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 4.71 | 0.03 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 0.17 | 46 | 0.87 | 0.02 |

Table 4.6 provides complete results for time on task for the self-assessment for Group A and Group B. Students in Group A spent an average of 22:34 minutes (SD = 11:19) on the self-assessment for module 2, while students in Group B spent an average

of 21:23 minutes (SD = 8:04) on the self-assessment for module 3. This difference was not statistically significant: t(46) = 0.42, p = 0.67.

Table 4.6: Self-Assessment, Time on Task, Group A v Group B

| **Time on Task** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 0:22:43 | 11:45.04 | 01:42.82 |
| | ***Group A*** | 23 | 0:22:34 | 11:18.50 | 02:21.50 |
| | ***Group B*** | 25 | 0:21:23 | 08:04.50 | 01:36.90 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 1.62 | 0.21 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 0.42 | 46 | 0.67 | 01:11.50 |

Table 4.7 provides complete results for time on task for the self-assessment for students who completed their respective self-assessment once and those who completed it multiple times. Students who completed their respective self-assessment multiple times (M = 39:31, SD = 10:30) spent more time on the activity than those who only completed the exam once (M = 19:55, SD = 7:17). This difference was determined to be significant: t(46) = -5.44 , p < 0.001.

Table 4.7: Self-Assessment, Time on Task, Once v Multiple

| **Time on Task** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 0:22:43 | 11:45.00 | 01:42.80 |
| | ***Once*** | 43 | 0:19:55 | 07:17.30 | 01:06.70 |
| | ***Multiple*** | 5 | 0:39:31 | 10:30.90 | 04:42.20 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 1.07 | 0.31 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | -5.44 | 46 | $< 0.001^{***}$ | -00:19:36.49 |

*** $p \leq 0.001$

Table 4.8 provides complete results for time on task for the self-assessment for students who earned a course grade of "A" and those who did not. Students who received an A in the course spent an average of 19:18 minutes (SD = 13:22) on their respective self-assessment, while those who did not make an A spent an average of 22:39 (SD = 8:32) on their activity. This difference was not significant, t(46) = -0.98 , p = 0.33.

Table 4.8: Self-Assessment, Time on Task, "A" v Not "A"

| **Time on Task** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 0:22:43 | 11:45.00 | 01:42.80 |
| | ***>= 89.50 ("A")*** | 10 | 0:19:18 | 13:22.30 | 04:13.70 |
| | ***< 89.50 (not "A")*** | 38 | 0:22:39 | 08:32.20 | 01:23.10 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 1.26 | 0.27 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | -0.98 | 46 | 0.33 | -00:03:26.56 |

Table 4.9 provides complete results for mean score on respective self-assessments. Group A completed the self-assessment for module 2 and Group B completed the self-assessment for module 3. Students in Group A scored an average of 90.35 (SD = 9.87) on the self-assessment for module 2, while students in Group B scored an average of 82.52 (SD = 17.27) on the self-assessment for module 3. A Levene's Test for Equality of Variances was performed and it was found that the two groups were not equal in the variability on their respective self-assessment. The mean score differences between Groups A and B were not statistically significant: t (46) = 1.91, p = 0.06.

Table 4.9: Score on Self-Assessment, Group A v Group B

| **Score on Self-Assessment** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 86.27 | 14.62 | 2.10 |
| | ***Group A (Module 2)*** | 23 | 90.36 | 9.87 | 2.06 |
| | ***Group B (Module 3)*** | 25 | 82.52 | 17.27 | 3.45 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 4.22 | 0.05 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 1.91 | 46 | 0.06 | 7.84 |

Table 4.10 provides complete results for mean score on respective self-assessment for students who completed the self-assessment once and those who completed it multiple

times. The “Once” category includes the Group A students who completed the module 2 self-assessment once and the Group B students who completed the module 3 self-assessment once. The “Multiple” category includes the Group A students who completed the module 2 self-assessment multiple times and the Group B students who completed the module 3 self-assessment multiple times. Students who completed their respective self-assessment once scored an average of 86.35 (SD = 15.21) on their respective self-assessment, while those who completed their self-assessment multiple times scored an average of 85.65 (SD = 9.04). The difference in the mean scores between students who completed the self-assessment once and those who completed it multiple times was not statistically significant: t (46) = 0.10, p = 0.92.

Table 4.10: Score on Self-Assessment, Once v Multiple

| **Score on Self-Assessment** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 86.27 | 14.62 | 2.11 |
| | ***Once*** | 43 | 86.35 | 15.21 | 2.32 |
| | ***Multiple*** | 5 | 85.65 | 9.04 | 4.04 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 0.47 | 0.50 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 0.10 | 46 | 0.92 | 0.69 |

Table 4.11 provides complete results for mean score on respective self-assessment for students who received a course grade of “A” and those who did not. Students who received an A in the course scored an average of 96.52 (SD = 5.99) on their respective

self-assessment, while those who did not scored an average of 83.58 (SD = 15.06). The difference in the mean scores between students who received a course grade of "A" and those who did not was not statistically significant: t (46) = 2.65, p = 0.01.

Table 4.11: Score on Self-Assessment, "A" v Not "A"

| **Score on Self-Assessment** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 86.27 | 14.62 | 2.11 |
| | ***>= 89.50 ("A")*** | 10 | 96.52 | 5.99 | 1.90 |
| | ***< 89.50 (not "A")*** | 38 | 83.58 | 15.06 | 2.44 |
| | | | | | |
| **Levene's Test for Equality of Variances:** | | | | **F** | **Sig.** |
| | Equal variances assumed | | | 4.05 | 0.05 |
| | | | | | |
| **Independent Samples T-Test:** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| | Equal variances assumed | 2.65 | 46 | 0.01 | 12.94 |

**Research question 2.** Do students who take advantage of the formative assessment opportunities score higher on module exams? The second hypothesis argued that students who access the formative assessment opportunities on a consistent basis will score higher on module exams than those who do not.

Tables 4.12, 4.13, and 4.14 provide complete results for scores on module 1, 2, 3, and 4 exams.

Table 4.12: Mean Scores for Exams 1, 2, 3, & 4

| Module Exam Scores | | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| **M1Exam** | Total | 48 | 93.15 | 8.39 | 1.21 |
| | A | 23 | 94.20 | 6.83 | 1.42 |
| | B | 25 | 92.18 | 9.65 | 1.93 |
| | | | | | |
| **M2Exam** | Total | 48 | 92.04 | 9.02 | 1.30 |
| | A | 23 | 93.81 | 5.68 | 1.19 |
| | B | 25 | 90.4 | 11.12 | 2.22 |
| | | | | | |
| **M3Exam** | Total | 48 | 92.73 | 6.69 | 0.97 |
| | A | 23 | 94.11 | 6.09 | 1.27 |
| | B | 25 | 91.47 | 7.08 | 1.42 |
| | | | | | |
| **M4Exam** | Total | 48 | 67.92 | 11.031 | 1.59 |
| | A | 23 | 68.61 | 10.54 | 2.20 |
| | B | 25 | 67.28 | 11.65 | 2.33 |

Table 4.13: Levene's Test for Equality of Variance for Module Exams, Group A versus Group B

| | | F | Sig. |
|---|---|---|---|
| **M1Exam** | Equal variances assumed | 1.05 | 0.31 |
| **M2Exam** | Equal variances assumed | 2.20 | 0.15 |
| **M3Exam** | Equal variances assumed | 0.55 | 0.46 |
| **M4Exam** | Equal variances assumed | 0.03 | 0.86 |

Table 4.14: T-Test for Module Exams, Group A versus Group B

| | | t | df | Sig. (2-tailed) | Mean Difference |
|---|---|---|---|---|---|
| **M1Exam** | Equal variances assumed | 0.83 | 46 | 0.41 | 2.03 |
| **M2Exam** | Equal variances assumed | 1.32 | 46 | 0.19 | 3.42 |
| **M3Exam** | Equal variances assumed | 1.38 | 46 | 0.18 | 2.64 |
| **M4Exam** | Equal variances assumed | 0.41 | 46 | 0.68 | 1.33 |

No students were given a self-assessment for module 1. Group A had a module 1 exam mean score of 94.20 (SD = 6.83) while Group B had a mean of 92.18 (SD = 9.65). An independent samples t-test was conducted and it was determined that the difference was not significant: $t(46) = 0.83$, $p = 0.41$.

Students in Group A were given the self-assessment for module 2, while Group B was assigned the placebo. Group A had a module 2 exam mean score of 93.82 (SD = 5.68) while Group B had a mean of 90.40 (SD = 11.12). An independent samples t-test was conducted and it was determined that the difference was not significant: $t(46) = 1.32$, $p = 0.19$.

Students in Group B were given the self-assessment for module 3, while Group A was assigned the placebo. Group A had a module 3 exam mean score of 94.11 (SD = 6.10) Group B had a mean of 91.47 (SD = 7.08). An independent samples t-test was conducted and it was determined that the difference was not significant: $t(46) = 1.38$, $p = 0.18$.

For module 4 no students were given the treatment. Group A had a module 4 exam mean score of 68.61 (SD = 10.54) while Group B had a mean of 67.28 (SD = 11.65). An Independent samples t-test was conducted and it was determined that the difference was not significant: $t(46) = 0.41$, $p = 0.68$.

Table 4.15 provides complete results for the module exams scores taken in conjunction with the self-assessment, comparing completion of the practice once to completion of it multiple times. An overall comparison of module 2 and module 3 exams are provided to see how students who completed the self-assessment once compare to those who completed it multiple times. Module 2 exam results for Group A and module 3 exam results for Group B are also provided.

Table 4.15: Complete Results for Module Score, Based on Self-Assessment

| | | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 92.80 | 6.38 | 0.92 |
| **Module Score Associated with Self-Assessment** | ***Once*** | 43 | 92.43 | 6.59 | 1.00 |
| | ***Multiple*** | 5 | 96.00 | 2.90 | 1.30 |
| | | | | | |
| **Module 2 Score, Group A** | ***Once*** | 19 | 93.45 | 6.086 | 1.40 |
| | ***Multiple*** | 4 | 95.56 | 3.14 | 1.57 |
| | | | | | |
| **Module 3 Score, Group B** | ***Once*** | 24 | 91.21 | 7.10 | 1.45 |
| | ***Multiple*** | 1 | 97.78 | . | . |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| **Module Score Associated with Self-Assessment** | Equal variances assumed | | | 3.49 | 0.07 |
| | | | | | |
| **Module 2 Score, Group A** | Equal variances assumed | | | 2.77 | 0.11 |
| | | | | | |
| **Module 3 Score, Group B** | Equal variances assumed | | | . | . |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| **Module Score Associated with Self-Assessment** | Equal variances assumed | -1.19 | 46 | 0.24 | -3.57 |
| | | | | | |
| **Module 2 Score, Group A** | Equal variances assumed | -0.67 | 21 | 0.51 | -2.11 |
| | | | | | |
| **Module 3 Score, Group B** | Equal variances assumed | . | . | . | . |
| | | | | | |

Overall, results were not statistically significant. The mean module exam score for students completing the self-assessment once was 92.43 (SD = 6.59) and the mean score for students completed it multiple times was 96.00 (SD = 2.90). This difference was not significant: $t(46) = -1.19$, $p = 0.24$. The mean module 2 exam score for Group A students completing the self-assessment once was 93.45 (SD = 6.09), and the mean for Group A students completing it multiple times was 95.56 (SD = 3.14). The difference

was not significant: $t(21) = -.067$, $p = 0.51$. The mean module 3 exam score for Group B students completing the self-assessment once was 91.21 (SD = 7.10), and the mean for Group B student completing it multiple times was 97.78 (SD = 0.0). An independent samples t-test could not be run since there was only one student who completed the self-assessment multiple times.

**Research question 3.** Do students who take advantage of the formative assessment opportunities score higher on the final exam? The hypothesis for this research question argues that students who access the formative assessment opportunities on a consistent basis will score higher on the final exam than those who do not.

Table 4.16 provides complete results for all questions on the Final Exam for students in Groups A and B, students who completed their respective self-assessment once and multiple times, and for students who received a course grade of "A" and those who did not.

Table 4.16: Complete Results for Final Exam, All Questions

| **Score on Final Exam** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 73.31 | 12.08 | 1.74 |
| | ***Group A*** | 23 | 76.75 | 10.67 | 2.23 |
| | ***Group B*** | 25 | 70.13 | 12.62 | 2.52 |
| | | | | | |
| | ***Once*** | 43 | 72.37 | 12.20 | 1.86 |
| | ***Multiple*** | 5 | 81.33 | 7.77 | 3.48 |
| | | | | | |
| | ***>= 89.50*** | 10 | 85.60 | 8.19 | 2.59 |
| | ***< 89.50*** | 38 | 70.07 | 10.83 | 1.76 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| ***Group A v Group B*** | Equal variances assumed | | | 0.23 | 0.63 |
| | | | | | |
| ***Once vs Multiple*** | Equal variances assumed | | | 0.83 | 0.37 |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances assumed | | | 1.28 | 0.27 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| ***Group A v Group B*** | Equal variances assumed | 1.95 | 46 | 0.06 | 6.62 |
| | | | | | |
| ***Once vs Multiple*** | Equal variances assumed | -1.60 | 46 | 0.12 | -8.96 |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances assumed | 4.22 | 46 | < 0.001*** | 15.53 |

***$p \leq 0.001$

Group A had a final exam mean score of 76.75 (SD = 10.67) on the total final exam while Group B had a mean of 70.13 (SD = 12.62). An independent samples t-test was conducted and the difference was not statistically significant: $t(46) = 1.95$, $p = 0.06$.

Students who completed their respective self-assessment once had a final exam mean score of 72.37(SD = 12.20). Students who completed their respective self-assessment multiple times had a final exam mean score of 81.33 (SD = 7.77). An

independent samples t-test was conducted and the difference was not statistically significant: $t(46) = -1.60$, $p = 0.12$.

Students who received a course grade of "A" had a final exam mean score of 85.60 (SD = 8.19). Students who completed their respective self-assessment multiple times had a final exam mean score of 70.07 (SD = 10.83). An independent samples t-test was conducted and the difference was statistically significant: $t(46) = 4.22$, $p < 0.001$.

Table 4.17 provides complete results for module 2 questions on the final exam for students in Groups A and B, Group A students who completed the self-assessment once and multiple times, and for students who received a course grade of "A" and those who did not. For module 2, Group A received the self-assessment and Group B received the placebo.

Table 4.17: Complete Results for Final Exam, Module 2 Questions

| **Score on Final Exam** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 79.86 | 18.43 | 2.66 |
| | ***Group A (Treatment)*** | 23 | 85.51 | 14.29 | 2.98 |
| | ***Group B (Placebo)*** | 25 | 74.67 | 20.48 | 4.10 |
| | | | | | |
| | ***Once (Group A only)*** | 19 | 84.21 | 14.49 | 3.33 |
| | ***Multiple (Group A only)*** | 4 | 91.67 | 13.23 | 6.61 |
| | | | | | |
| | ***>= 89.50*** | 10 | 95.56 | 6.31 | 1.99 |
| | ***< 89.50*** | 38 | 75.73 | 18.38 | 2.98 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| ***Group A v Group B*** | Equal variances assumed | | | 2.02 | 0.16 |
| | | | | | |
| ***Once vs Multiple (Group A only)*** | Equal variances assumed | | | 0.28 | 0.60 |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances assumed | | | 5.50 | 0.02 |
| | Equal variances not assumed | | | | |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| ***Group A v Group B*** | Equal variances assumed | 2.11 | 46 | 0.04 | 10.84 |
| | | | | | |
| ***Once vs Multiple (Group A only)*** | Equal variances assumed | -0.95 | 21 | 0.36 | -7.46 |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances assumed | 3.34 | 46 | 0.002 | 19.82 |

Group A had a final exam, module 2 questions mean score of 85.51 (SD = 14.29) while Group B had a mean of 74.67 (SD = 20.48). An independent samples t-test was conducted and the difference was not statistically significant: $t(46) = 2.11$, $p = 0.04$.

Students in Group A who completed the module 2 practice once had a mean score of 84.21 (SD = 14.50) on module 2 questions within the final exam, and those who

completed the self-assessment multiple times had a mean of 91.67 (SD = 13.23). An independent samples t-test was conducted and it was determined that the difference was not significant: $t(21) = -.95$, $p = 0.36$.

Students who received a course grade of "A" had a final exam, module 2 questions mean score of 95.57 (SD = 6.31). Students who did not had a mean score of 75.73 (SD = 18.38). The difference between the scores of students who received a course grade of "A" and those who did not was not statistically significant: $t(46) = 3.34$, $p = 0.002$.

Table 4.18 provides complete results for module 3 questions on the final exam for students in Groups A and B, Group B students who completed the self-assessment once and multiple times, and for students who received a course grade of "A" and those who did not. For module 3, Group B received the self-assessment and Group A received the placebo.

Table 4.18: Complete Results for Final Exam, Module 3 Questions

| **Score on Final Exam** | | **N** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|---|
| **Group Statistics** | ***All students*** | 48 | 71.76 | 14.12 | 2.04 |
| | ***Group A (Placebo)*** | 23 | 75.12 | 10.03 | 2.09 |
| | ***Group B (Treatment)*** | 25 | 68.67 | 16.66 | 3.33 |
| | | | | | |
| | ***Once (Group B only)*** | 24 | 73.84 | 20.49 | 4.18 |
| | ***Multiple (Group B only)*** | 1 | 94.44 | . | . |
| | | | | | |
| | ***>= 89.50*** | 10 | 84.44 | 4.38 | 1.39 |
| | ***< 89.50*** | 38 | 68.42 | 13.92 | 2.26 |
| | | | | | |
| **Levene's Test for Equality of Variances** | | | | **F** | **Sig.** |
| ***Group A v Group B*** | Equal variances assumed | | | 1.79 | 0.19 |
| | | | | | |
| ***Once vs Multiple (Group B only)*** | Equal variances assumed | | | . | . |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances assumed | | | 4.09 | 0.05 |
| | | | | | |
| **Independent Samples T-Test** | | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** |
| ***Group A v Group B*** | Equal variances assumed | 1.61 | 46 | 0.12 | 6.45 |
| | | | | | |
| ***Once vs Multiple (Group B only)*** | Equal variances assumed | . | . | . | . |
| | | | | | |
| ***>= 89.50 v < 89.50*** | Equal variances not assumed | 3.57 | 46 | 0.001*** | 16.02 |

*** $p \leq 0.001$

Group A had a final exam, module 3 questions mean score of 75.12 (SD = 10.03) while Group B had a mean of 68.67 (SD = 16.66). An independent samples t-test was conducted and the difference was not statistically significant: $t(46) = 1.61$, $p = 0.12$.

Students in Group B who completed the module 3 self-assessment once had a mean score of 73.84 (SD = 20.49) on module 3 questions within the final exam, and the

student who completed the self-assessment multiple times had a mean of 94.44. An independent samples t-test could not be run.

Students who received a course grade of "A" had a final exam, module 3 questions mean score of 84.44 (SD = 4.38). Students who did not had a mean score of 68.42 (SD = 13.92). The difference between the scores of students who received a course grade of "A" and those who did was statistically significant: $t(46) = 3.57$, $p = 0.001$.

Pair sample t-tests were performed (Table 4.19) to determine whether there was an increase in learning from the pretest to the final exam for all questions on the final exam, module 2 questions, and module 3 questions. Further paired samples were performed to see if there was an increase in learning in the whole class, Group A, and Group B. Tables 4.19 provides complete results for the whole class: all questions on the final exam, module 2 questions, and module 3 questions.

Table 4.19: Paired Samples, Whole Class

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ***Pair 1: All Questions*** | Pretest | 60.12 | 48 | 17.18 | 2.48 |
| | Final Exam | 73.31 | 48 | 12.08 | 1.74 |
| | | | | | |
| ***Pair 2: Module 2 Questions*** | Pretest | 61.46 | 48 | 21.57 | 3.11 |
| | Final Exam | 79.86 | 48 | 18.43 | 2.66 |
| | | | | | |
| ***Pair 3: Module 3 Questions*** | Pretest | 59.03 | 48 | 15.99 | 2.31 |
| | Final Exam | 71.76 | 48 | 14.12 | 2.04 |
| | | | | | |
| **Dependent Samples T-Test** | | | **t** | **df** | **Sig. (2-tailed)** |
| ***Pair 1*** | *PretestTotal - FinalTotal* | | -4.60 | 47 | <0.001*** |
| ***Pair 2*** | *Pre2Questions - Final2Questions* | | -4.77 | 47 | <0.001*** |
| ***Pair 3*** | *Pre3Questions - Final3Questions* | | -4.67 | 47 | <0.001*** |

*** $p \leq 0.001$

Overall, there was a statistically significant difference in performance: students performed better on the final exam (M = 73.31, SD = 12.08) than on the pretest (M = 60.12, SD = 17.18): t(47) = -4.60, p <0.001. A statistically significant increase in performance occurred in answering module 2 questions on the final exam (M = 79.86, SD = 18.43) compared to the pretest (M = 61.46, SD = 21.57): t(47) = -4.77, p < 0.001. A statistically significant increase in performance also occurred in answering module 3 questions on the final exam (M = 71.76, SD = 14.12) compared to the pretest (M = 59.03, SD = 15.99): t(47) = -4.67, p <0.001.

Table 4.20 provides complete results for the Group A: all questions on the final exam, module 2 questions, and module 3 questions.

Table 4.20: Paired Samples, Group A

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ***Pair 1: All Questions*** | Pretest | 59.54 | 23 | 14.30 | 2.98 |
| | Final Exam | 76.75 | 23 | 10.67 | 2.23 |
| | | | | | |
| ***Pair 2: Module 2 Questions*** | Pretest | 58.94 | 23 | 19.37 | 4.04 |
| | Final Exam | 85.51 | 23 | 14.29 | 2.98 |
| | | | | | |
| ***Pair 3: Module 3 Questions*** | Pretest | 59.18 | 23 | 11.44 | 2.38 |
| | Final Exam | 75.12 | 23 | 10.03 | 2.09 |
| | | | | | |
| **Dependent Samples T-Test** | | | **t** | **df** | **Sig. (2-tailed)** |
| ***Pair 1*** | *PretestTotal - FinalTotal* | | -4.68 | 22 | <0.001*** |
| ***Pair 2*** | *Pre2Questions - Final2Questions* | | -5.85 | 22 | <0.001*** |
| ***Pair 3*** | *Pre3Questions - Final3Questions* | | -5.65 | 22 | <0.001*** |

*** $p \leq 0.001$

Overall, there was a statistically significant difference in performance of students in Group A: students performed better on the final exam (M = 76.75, SD = 10.67) than on the pretest (M = 59.54, SD = 14.30): t(22) = -4.68, p <0.001. A statistically significant increase in performance occurred in answering module 2 questions on the final exam (M = 85.51, SD = 14.27) compared to the pretest (M = 58.94, SD = 19.37): t(22) = -5.85, p < 0.001. A statistically significant increase in performance also occurred in answering module 3 questions on the final exam (M = 75.12, SD = 10.03) compared to the pretest (M = 59.18, SD = 11.44): t(22) = -5.65, p <0.001.

Table 4.21 provides complete results for the Group B: all questions on the final exam, module 2 questions, and module 3 questions.

Table 4.21: Paired Samples, Group B

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ***Pair 1: All Questions*** | Pretest | 60.66 | 25 | 19.75 | 3.95 |
| | Final Exam | 70.13 | 25 | 12.62 | 2.52 |
| | | | | | |
| ***Pair 2: Module 2 Questions*** | Pretest | 63.78 | 25 | 23.58 | 4.72 |
| | Final Exam | 74.67 | 25 | 20.48 | 4.10 |
| | | | | | |
| ***Pair 3: Module 3 Questions*** | Pretest | 58.89 | 25 | 19.51 | 3.90 |
| | Final Exam | 68.67 | 25 | 16.66 | 3.33 |
| | | | | | |
| **Dependent Samples T-Test** | | | **t** | **df** | **Sig. (2-tailed)** |
| ***Pair 1*** | *PretestTotal - FinalTotal* | | -2.22 | 24 | 0.04 |
| ***Pair 2*** | *Pre2Questions - Final2Questions* | | -1.88 | 24 | 0.07 |
| ***Pair 3*** | *Pre3Questions - Final3Questions* | | -2.16 | 24 | 0.04 |

Overall, there was not a statistically significant difference in performance of students in Group B from the pretest (M = 60.66, SD = 19.75) to the final exam (M = 70.13, SD = 12.62) than on the pretest: t(24) = -2.218, p = 0.04. A statistically significant increase in performance did not occur in answering module 2 questions on the final exam (M = 74.67, SD = 20.48) compared to the pretest (M = 63.78, SD = 4.72): t(25) = -1.88, p = 0.07. Further, there was not a statistically significant increase in performance in answering module 3 questions on the final exam (M = 68.67, SD = 16.67) compared to the pretest (M = 58.89, SD = 19.51): t(22) = -2.16, p = 0.04.

# Chapter 5

# Discussion

## Introduction

The purpose of this study was to establish the effectiveness of formative assessment opportunities in an online medical terminology course. It also sought to determine whether students would utilize such a tool given the opportunity.

Students enrolled in the course were randomly divided into two groups: A and B. The course content was divided into four modules:

- Module 1: introductory information and the respiratory system;
- Module 2: urinary, reproductive, cardiovascular and lymphatic, and digestive systems;
- Module 3: eye, ear, and plural endings, musculoskeletal, nervous, and endocrine systems; and
- Module 4: terms specific to the radiology profession.

All students were required to take a pretest to assess their beginning knowledge of medical terminology and to help establish equality of the two groups. For each module students were required to complete a module exam and a discussion activity. Only the module exam scores were included in this study.

All students completed module 1 and module 4 without access to treatment (a self-assessment). For module 2, students in Group A were assigned a self-assessment

before gaining access to the module exam. Students in Group B were assigned a placebo to complete, which was an unrelated word puzzle. For module 3, students in Group B were assigned a self-assessment and students in Group A the placebo.

Students were allowed to complete their assigned self-assessment an unlimited number of times during the module availability time. Students were required to complete their assigned self-assessment at least once before gaining access to the associated module exam. Students were also required to complete the placebo activity once before gaining access to the associated module exam. Upon completion of the self-assessment, students were provided with corrective feedback.

**Equality of Groups**

Overall, Group A and Group B were equal in beginning knowledge of the content. This was determined from pretest scores, both collectively and also when subdivided into Module 2 and Module 3 content. Groups A and B preformed equally in all areas of the pretest. This established equality of groups.

**First Research Hypothesis - Access**

The first hypothesis argued that higher-achieving students will access formative assessment opportunities more often than lower-achieving students. The results failed to confirm the hypothesis.

Overall, the students did not voluntarily take advantage of formative assessment opportunities. Of the 48 participants, only five students completed the self-assessment more than once. Four of the participants from Group A, which received the treatment for module 2 and the placebo for module 3, repeated the self-assessment. One Group A

participant completed the self-assessment a third time. Only one Group B student completed the formative assessment a second time and none a third time.

Examination of the self-assessment completion dates shows that 32 of the 48 participants completed their self-assessment on the same day they completed the associated module exam. See Appendix E for a list of course activity completion dates for each participant. It is unknown why students did not take full advantage of this potential learning opportunity. Not knowing whether the activity would have an impact on their performance may have been a factor. Pellegrino (2001) and Scott et al. (2008) discuss the importance of student buy-in. In the present study, it did not appear that student buy-in was obtained to do more than the minimum requirement. This rationale is supported by Kolistsky (2008) and further explained by Scott et al. (2008): students do not place the same value on formative assessments as they do on summative assessments.

While Shell et al. (2010) identified quality of feedback as a vital issue in formative assessments; it does not appear that students in this study placed a high value on the feedback. The self-assessment provided feedback on each question based on student selection; however, students did not complete the self-assessment multiple times.

Further, this course is worth only one credit hour, so students may not have wanted to put in the extra time into the course. This may have been a contributing factor to lack of student buy-in. Another explanation may be the students' inexperience with online courses. While no statistical data were gathered in this regard, it was anecdotally noted that the students were inexperienced in taking online courses. For many of the

students this was their first year in college, and they are most likely trying to adjust from high-school to collegiate academia standards, requirements, and external distractions.

However, one would assume that since this course is a pre-requisite for a professional program the students would go above and beyond what is required; however, that simply was not the case. Students completed the minimum requirement, which included only one self-assessment. It appeared as though the students lacked the motivation to take advantage of additional learning opportunities provided, or to take control of their learning process.

To address the specific cohort of students addressed in the hypothesis: higher-achieving students did not voluntarily take advantage of the self-assessment more than lower-achieving students, nor do they spend more time on the activity. Higher-achieving students were identified as those who received an overall course grade of 89.5 or higher. This equates to a letter grade of "A." This violates Kolistsky's (2008) assumption that the number of times a student takes a formative assessment directly correlates with his summative assessment grade and Angus and Watson's (2009) assumption that lower-achieving students access formative assessment opportunities less often. Perhaps, the higher-achieving students felt confident with their performance on the first attempt of the self-assessment, and therefore did not feel they needed a second attempt.

Only 10% of the 48 participants completed the self-assessment a second time and 2% a third time. This is an extremely low rate. However, it does provide evidence to support the notion that pre-professional students - both high- and low-achieving - do not take advantage of additional learning opportunities on their own volition. This is

consistent with the review reported by Aleven, Stahl, Schworm, Fischer, and Wallace (2003).

A closer look at the scores on the self-assessment shows that higher-achieving students outperform lower-achieving students on the self-assessment. This difference could indicate that performance on self-assessments may be an indicator of overall course grade. This difference could also be a result of the sheer fact that higher-achieving students generally perform better in all aspects of their courses and took the self-assessment opportunity more seriously.

While not statistically significant, the five students who completed the self-assessment a second time, had a lower mean score ($M = 84.35$, $SD = 11.75$) than those who only completed the activity once. Further, the one student who completed the activity a third time had a score of 60.87 on her second completion, compared to a mean score of 91.30 ($SD = 9.39$) for the remaining four students. On her third attempt, the student had a score of 95.65. These data support Karpicke's (2009) notion that students use formative assessment opportunities as a gauge of their current level of knowledge prior to summative assessments instead of as a learning tool. Once students feel confident, they do not continue to study.

Students at this level of education may not have the metacognitive ability (neither the skill nor the will) required to successfully use optional learning tools. Black and William (1998), Clark et al., (2006), and Shell et al. (2010) all identify motivation as a key element in the learning process. This study did not provide evidence that students have the intrinsic motivation to utilize learning tools on their own volition.

Even though the hypothesis failed to be confirmed and students did not use the self-assessment as intended, using it as a gauge of their current level of knowledge is not entirely negative. After completing the self-assessment, students will know if they need to continue to study and then re-evaluate with the self-assessment or if they are ready for the module exam. However, this will only be beneficial if students complete the self-assessment at a time that will allow adequate additional study time. Closing the self-assessment a few days before the module exam is due may help accomplish this.

While it does not appear that completing the self-assessment multiple times has an influence on exam scores, it is possible that the score on the self-assessment could be an indicator of overall course grade. This would provide the course instructor a way to identify students who may need remediation. Upon reviewing initial self-assessment scores, the instructor could identify lower-scoring students and offer them additional assignments and the opportunity to re-evaluate using the self-assessment. However, using the assessment in this fashion may change it from formative to summative in nature and could be viewed negatively by the students. A possible solution would be to make an announcement to the students that remediation is available on student request – after student have completed and reviewed the formative assessment.

**Second Research Hypothesis – Immediate Impact**

The second hypothesis argued that students who access the formative assessment opportunities on a consistent basis will score higher on module exams than those who do not. The results failed to confirm the hypothesis.

This study did not find a statistically significant difference in module exam scores when students completed the associated self-assessment, did not complete the activity, or completed the activity multiple times. Results from this study contradict those from Zakrzewski and Bull (1998) that students who complete formative assessment activities will outperform those who do not on related content exams. As stated previously, a very low percentage of students completed the self-assessment multiple times and this could have impacted the results.

The unconstructive results from this study may be related to students completing the self-assessment in close proximity to the module exam due date, and viewing the activity as a gauge of their current level of knowledge rather than a learning tool. By waiting until the last day to complete the self-assessment, students did not allow enough time to benefit from the feedback provided. This also supports the notion that students did not use the self-assessment for their intended purpose; rather they completed it as a course requirement.

**Third Research Hypothesis – Long-term Impact**

The third hypothesis argued those students who access the formative assessment opportunities on a consistent basis will score higher on the final exam than those who do not. The results failed to confirm the hypothesis.

This study did not find significant differences in final exam scores when students completed the self-assessment or did not. Results from this study contradict those from Olson and McDonald (2004) that students who complete formative assessment activities will outperform those who do not on the final exam. Further, completing the self-

assessment multiple times did not have an impact on any part of the final exam. Completion of the self-assessment does not have a solid impact on long-term retention of the material.

While there was not a statistical significant, there was a practical significant difference between students who completed the exam once and those who completed it multiple times. For the overall final exam, the five students who completed their self-assessment multiple times scored an average of 8.96 points higher than those who completed it once. For module 2 questions on the final exam, the four students who completed their self-assessment multiple times scored an average of 7.46 points higher than those who completed it once. For module 3 questions on the final exam, the one student who completed her self-assessment multiple times scored 20.60 points higher than those who completed it once. This difference is considered practical as it could make a letter grade difference, and it could make a difference in a student being considered for admittance into the radiography program.

It does appear that the overall format of the course results in a positive learning gain of the course content. There was a statistically significant increase from the pretest to the final exam. Further, students in Group A had a statistically significant increase from the pretest to the final exam. While not statistically significant, students in Group B also had increase score from the pretest to the final exam. Nevertheless, the course format works; students know more at the end than when they start. The data also show that the self-assessments did not have a negative effect on learning.

# Chapter 6

# Conclusions

## Introduction

Students in an online medical terminology course were randomly divided into two groups. Scores from 48 students' module exam and final exam scores were evaluated to determine whether self-assessments are utilized and effective.

It was found that students do not to take advantage of additional learning opportunities unless required. Students behave as if the self-assessment is strictly a course requirement. This may be a result of absence of buy-in because of a lack of intrinsic motivation or metacognitive skill. While this was not the initial intent of the self-assessment, it does have positive implications on how to provide remediation opportunities for students who may need it. Students lack the motivation to do more than what is required.

The inclusion of formative assessment opportunities does not have an impact on summative exams: Module exam scores did not increase when self-assessments were completed once. While the results were not statistically significant, completing the self-assessment multiple times seemed to have a practical impact on the final exam.

It is evident that learning did occur from the beginning of the course to the final exam. This learning does not seem to be a result of the completion of the self-assessment.

It does not appear that self-assessments have a negative impact on learning so their inclusion in a course would not hamper the learning process.

**Limitations of the Study**

The scope of this study was limited by the lack of students completing the self-assessment multiple times. This prevented the capture of conclusive results as to the effectiveness of taking self-assessments multiple times. Another limitation is the self-assessment completion day. Most students completed the self-assessment on the same day they completed the associated module exam. This late completion turns the tool into a readiness gauge instead of the intended learning tool.

Finally, the research was also limited by the absence of student perception captured. This study only captured quantitative data. An investigation of why students did not complete the self-assessment multiple times or why they waited to take it might help guide the instructional design of such activities.

**Recommendations for Future Research**

A follow-up survey to address the last limitation might help instructors create meaningful learning activities. This survey could also assess the perception of self-assessments after completing the placebo activity to see if it was a factor in the lower number of Group B students completing the self-assessment a second time.

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# Appendices

## Appendix A: Recruitment Letter

IRB # 20110211470 EX

Dear Students,

I am currently working on my PhD in educational studies at the University of Nebraska – Lincoln. For this program, I have to complete a research project. You have the opportunity to take part in the research project because you are enrolled in a Radiologic Science Medical Terminology course this semester. The research project is investigating the role of computer-based formative assessments in an online medical terminology course. Please be assured that your course grade will not be affected by participation or nonparticipation in this study.

The attached consent form explains in detail what data I will be looking for. I want to assure you that the project I am completing will not harm you. I would appreciate it if you would read the attached consent form and complete the RESEARCH CONSENT assessment as soon as possible. You will find the assessment on the RADS 1011 Radiologic Science Medical Terminology course homepage in Blackboard©.

If you have questions, please feel free to contact me.

Jammie T. Wilbanks, MSRS, RT(R)

## Appendix B: IRB, UNL

University of Nebraska Lincoln

COLLEGE OF EDUCATION AND HUMAN SERVICES

INFORMED CONSENT FORM

IRB# 20110211470 EX

***Identification of Project:***

Investigating Computer-Based Formative Assessments In A Medical Terminology Course.

***Purpose of the Research:***

This is a research project that will investigate the use of computer-based formative assessments in a medical terminology course. You are being asked to participate because you are enrolled in a RADS 1011 Radiologic Science Medical Terminology course.

***Procedures:***

For each of the course modules, students will be provided a table of contents with directions on how to progress through the module. At times students will be asked to complete additional learning activities based on the modules. The learning activities will be accessed and/or completed through Blackboard©. The time required to participate will be dependent on your level of participation. It is anticipated that you will spend 30 minutes to 2 hours on each module of the study. Exam scores will be used for comparison and analysis.

***Risks and/or Discomforts:***

There are no risks or discomforts associated with this research.

***Benefits:***

A possible benefit of this research is better understanding and retention of medical terminology.

***Confidentiality:***

Any information obtained during this study which could identify you will be kept strictly confidential. The privacy of participants will be maintained throughout the study. The information obtained in this study may be published in professional journals or presented at professional meetings but the data will be reported as aggregated data.

***Compensation:***

There will be no compensation for participating in this research.

206 Avery Hall / P.O. 880417 / Lincoln, NE 68588-0127
(402) 472-3041 / FAX (402) 472-8597

***Opportunity to Ask Questions:***

You many ask any questions concerning this research and how those questions answered at any time by contacting the investigators at the numbers listed below. If you have any questions about your rights as a research participant or to report any concerns, please contact the UNL Institutional Review Board at 402-472-6965

***Freedom to Withdraw:***

Participation in this study is voluntary. You can refuse to participate or withdraw at any time without harming your relationship with the researchers, the University of Nebraska-Lincoln, or Midwestern State University, or in any other way receive a penalty or loss of benefits to which you are otherwise entitled.

***Consent, Right to Receive a Copy:***

You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

***Signature of Participant:***

Please go to the RESEARCH CONSENT assessment on the course homepage to give consent or not.

***Name and Phone number of investigator(s)***

*Jammie T. Wilbanks, MSRS, RT(R), Principal Investigator* *Phone (940) 397-4664*

*Dr. David Brooks, Secondary Investigator* *Phone (402) 472-2018*

_____

## Appendix C: IRB, MSU


Human Subjects In Research Committee

Institutional Review Board in Compliance with 45 CFR 46

MSU Policy 2.37

**MEMORANDUM**

TO: Jammie T. Wilbanks

RE: Investigating Computer-Based Formative Assessments in a Medical Terminology Course

DATE: January 10, 2011

Your proposal for research utilizing human subjects has been reviewed and approved by the above named committee.

The number assigned this project is 11010704

Please include this file number in any presentation or publication arising from this research. You may be required to place a copy of this letter within the thesis or other class, department, or college documentation. This approval is valid for one calendar year following granting of approval status. Your may request an extension by submitting a letter requesting such to the HSRC committee chair.

Respectfully,

Chair, Human Subjects in Research Committee (IRB)

## Appendix D: Research Consent



**Research Consent**

Jammie Wilbanks
Started: February 10, 2011 12:33 PM
Questions: 12

Finish Save All Help

**1. Identification of Project** (Points: 10)

The title of this project is "Investigating Computer-Based Formative Assessments In A Medical Terminology Course."

1. I have read this section

Save Answer

**2. Research Approval** (Points: 10)

This research study has been approved by the IRB at University of Nebraska Lincoln (IRB# 20110211470 EX) and the HSR at Midwestern State University (#11010704)

1. I have read this section.

Save Answer

**3. Purpose of the Research** (Points: 10)

This is a research project that will investigate the use of computer-based formative assessments in a medical terminology course. You are being asked to participate because you are enrolled in a RADS 1011 Radiologic Science Medical Terminology course.

1. I have read this section.

Save Answer

**4. Procedures** (Points: 10)

For each of the course modules, students will be provided a table of contents with directions on hov to progress through the module. At times students will be asked to complete additional learning activities based on the modules. The learning activities will be accessed and/or completed through Blackboard©. The time required to participate will be dependent on your level of participation. It is anticipated that you will spend 30 minutes to 2 hours on each module of the study. Exam scores will be used for comparison and analysis.

1. I have read this section.

Save Answer

**5. Risks and/or Discomforts** (Points: 10)

There are no risks or discomforts associated with this research.

1. I have read this section.

Save Answer

**6. Benefits** (Points: 10)

A possible benefit of this research is better understanding and retention of medical terminology.

1. I have read this section.

Save Answer

**7. Confidentiality** (Points: 10)

Any information obtained during this study which could identify you will be kept strictly confidential The privacy of participants will be maintained throughout the study. The information obtained in this study may be published in professional journals or presented at professional meetings but the data will be reported as aggregated data.

1. I have read this section.

Save Answer

**8. Compensation** (Points: 10)

There will be no compensation for participating in this research.

1. I have read this section.

Save Answer

**9. Opportunities to Ask Questions** (Points: 10)

You many ask any questions concerning this research and how those questions answered at any time by contacting the investigators at the numbers listed below. If you have any questions about your rights as a research participant or to report any concerns, please contact the UNL Institutional Review Board at 402-472-6965

1. I have read this section.

Save Answer

**10. Freedom to Withdraw** (Points: 10)

Participation in this study is voluntary. You can refuse to participate or withdraw at any time without harming your relationship with the researchers, the University of Nebraska-Lincoln, or Midwestern State University, or in any other way receive a penalty or loss of benefits to which you are otherwise entitled.

1. I have read this section.

Save Answer

**11. Name and Phone Number of Investigators** (Points: 10)

Jammie T. Wilbanks, MSRS, RT(R), Principal Investigator Phone (940) 397-4664

Dr. David Brooks, Secondary Investigator Phone (402) 472-2018

1. I have read this section.

Save Answer

**12. Consent, Right to Receive a Copy** (Points: 10)

You are voluntarily making a decision whether or not to participate in this research study. Your selection of "I give consent" certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

1. I give consent.

2. I do not give consent

Save Answer

Finish Save All Help

## Appendix E: Activity Completion Dates

Day 1 = First day of class; Day 112 = Last day the final exam was available

| Participant | Group | Pretest | Module1 Exam *due on day 24* | | Module2 Practice Activity | Module2 Practice Activity *2nd attempt* | Module2 Practice Activity *3rd attempt* | Module2 Exam *due on day 45* | Module2 Lapse |
|---|---|---|---|---|---|---|---|---|---|
| 1 | B | 7 | 21 | | 45 | -- | -- | 45 | 0 |
| 2 | A | 8 | 24 | | 45 | 45 | -- | 45 | 0 |
| 3 | B | 3 | 23 | | 44 | -- | -- | 45 | 1 |
| 4 | B | 4 | 21 | | 42 | -- | -- | 42 | 0 |
| 5 | B | 5 | 26 | | 45 | -- | -- | 45 | 0 |
| 6 | A | 3 | 23 | | 45 | -- | -- | 45 | 0 |
| 7 | B | 3 | 24 | | 45 | -- | -- | 45 | 0 |
| 9 | B | 12 | 23 | | 44 | -- | -- | 44 | 0 |
| 10 | A | 12 | 18 | | 43 | -- | -- | 43 | 0 |
| 11 | A | 3 | 24 | | 45 | -- | -- | 45 | 0 |
| 12 | B | 6 | 24 | | 42 | -- | -- | 45 | 3 |
| 13 | A | 1 | 81 | | 33 | -- | -- | 42 | 9 |
| 14 | B | 12 | 24 | | 45 | -- | -- | 45 | 0 |
| 16 | A | 4 | 23 | | 37 | -- | -- | 37 | 0 |
| 17 | A | 3 | 17 | | 41 | 41 | -- | 43 | 2 |
| 19 | B | 10 | 24 | | 45 | -- | -- | 45 | 0 |
| 21 | A | 2 | 24 | | 38 | 38 | 45 | 45 | 7 |
| 22 | B | 10 | 23 | | 44 | -- | -- | 45 | 1 |
| 23 | B | 3 | 24 | | 37 | -- | -- | 45 | 8 |
| 24 | A | 5 | 22 | | 45 | -- | -- | 45 | 0 |
| 25 | A | 3 | 22 | | 44 | -- | -- | 44 | 0 |
| 26 | A | -5 | 21 | | 43 | 43 | -- | 43 | 0 |
| 27 | A | 4 | 24 | | 46 | -- | -- | 46 | 0 |
| 31 | B | 7 | 23 | | 44 | -- | -- | 44 | 0 |
| 32 | A | 10 | 24 | | 45 | -- | -- | 45 | 0 |
| 33 | B | 12 | 24 | | 45 | -- | -- | 45 | 0 |
| 34 | A | 12 | 24 | | 47 | -- | -- | 47 | 0 |
| 35 | A | 6 | 24 | | 44 | -- | -- | 45 | 1 |
| 36 | A | 10 | 24 | | 45 | -- | -- | 45 | 0 |
| 37 | B | 2 | 24 | | 45 | -- | -- | 45 | 0 |
| 38 | A | 11 | 24 | | 45 | -- | -- | 45 | 0 |
| 40 | B | 11 | 24 | | 38 | -- | -- | 38 | 0 |

| Participant | Group | Pretest | Module1 Exam *due on day 24* | | Module2 Practice Activity | Module2 Practice Activity *2nd attempt* | Module2 Practice Activity *3rd attempt* | Module2 Exam *due on day 45* | Module2 Lapse |
|---|---|---|---|---|---|---|---|---|---|
| 42 | A | 4 | 21 | | 41 | -- | -- | 42 | 1 |
| 43 | B | 3 | 22 | | 44 | -- | -- | 44 | 0 |
| 46 | A | 7 | 24 | | 43 | -- | -- | 45 | 2 |
| 47 | B | 11 | 24 | | 45 | -- | -- | 45 | 0 |
| 48 | A | 9 | 22 | | 42 | -- | -- | 44 | 2 |
| 51 | B | 10 | 24 | | 45 | -- | -- | 45 | 0 |
| 52 | A | 13 | 24 | | 45 | -- | -- | 45 | 0 |
| 53 | B | 5 | 24 | | 44 | -- | -- | 45 | 1 |
| 54 | B | 3 | 18 | | 43 | -- | -- | 43 | 0 |
| 55 | B | 3 | 24 | | 39 | -- | -- | 43 | 4 |
| 56 | B | 3 | 21 | | 47 | -- | -- | 47 | 0 |
| 57 | A | 2 | 23 | | 44 | -- | -- | 44 | 0 |
| 58 | B | 12 | 24 | | 45 | -- | -- | 45 | 0 |
| 59 | B | 6 | 21 | | 44 | -- | -- | 44 | 0 |
| 60 | A | 2 | 23 | | 43 | -- | -- | 43 | 0 |
| 61 | B | 1 | 21 | | 37 | -- | -- | 42 | 5 |

| Participant | Group | Module3 Practice Activity | Module3 Practice Activity *2nd attempt* | Module3 Exam *due on day 66* | Module3 Lapse | | Module4 Exam *due on day 87* | | Final Exam *available day 94 - 112* |
|---|---|---|---|---|---|---|---|---|---|
| 1 | B | 66 | -- | 66 | 0 | | 82 | | 112 |
| 2 | A | 66 | -- | 66 | 0 | | 87 | | 103 |
| 3 | B | 63 | -- | 63 | 0 | | 84 | | 102 |
| 4 | B | 63 | -- | 63 | 0 | | 85 | | 103 |
| 5 | B | 65 | -- | 65 | 0 | | 87 | | 94 |
| 6 | A | 65 | -- | 65 | 0 | | 86 | | 110 |
| 7 | B | 66 | -- | 66 | 0 | | 91 | | 95 |
| 9 | B | 62 | -- | 65 | 3 | | 85 | | 95 |
| 10 | A | 61 | -- | 61 | 0 | | 80 | | 110 |
| 11 | A | 66 | -- | 66 | 0 | | 87 | | 95 |
| 12 | B | 66 | -- | 66 | 0 | | 87 | | 112 |
| 13 | A | 42 | -- | 62 | 20 | | 79 | | 105 |
| 14 | B | 66 | -- | 66 | 0 | | 87 | | 103 |
| 16 | A | 65 | -- | 65 | 0 | | 82 | | 94 |
| 17 | A | 53 | -- | 62 | 9 | | 80 | | 95 |
| 19 | B | 66 | -- | 66 | 0 | | 87 | | 110 |
| 21 | A | 65 | -- | 65 | 0 | | 82 | | 111 |
| 22 | B | 54 | -- | 58 | 4 | | 87 | | 101 |
| 23 | B | 66 | -- | 66 | 0 | | 87 | | 102 |
| 24 | A | 66 | -- | 66 | 0 | | 82 | | 105 |
| 25 | A | 64 | -- | 64 | 0 | | 83 | | 103 |
| 26 | A | 66 | -- | 66 | 0 | | 85 | | 112 |
| 27 | A | 66 | -- | 66 | 0 | | 87 | | 94 |
| 31 | B | 65 | -- | 66 | 1 | | 87 | | 102 |
| 32 | A | 58 | -- | 63 | 5 | | 82 | | 95 |
| 33 | B | 66 | -- | 66 | 0 | | 87 | | 102 |
| 34 | A | 66 | -- | 66 | 0 | | 88 | | 102 |
| 35 | A | 58 | -- | 66 | 8 | | 87 | | 95 |
| 36 | A | 66 | -- | 66 | 0 | | 82 | | 105 |
| 37 | B | 66 | -- | 66 | 0 | | 87 | | 104 |
| 38 | A | 65 | -- | 65 | 0 | | 84 | | 108 |
| 40 | B | 64 | -- | 66 | 2 | | 86 | | 101 |
| 42 | A | 66 | -- | 66 | 0 | | 85 | | 103 |
| 43 | B | 66 | -- | 66 | 0 | | 87 | | 110 |
| 46 | A | 65 | -- | 66 | 1 | | 87 | | 102 |
| 47 | B | 66 | -- | 66 | 0 | | 87 | | 95 |
| 48 | A | 62 | -- | 63 | 1 | | 86 | | 108 |

| Participant | Group | Module3 Practice Activity | Module3 Practice Activity *2nd attempt* | Module3 Exam *due on day 66* | Module3 Lapse | | Module4 Exam *due on day 87* | | Final Exam *available day 94 - 112* |
|---|---|---|---|---|---|---|---|---|---|
| 51 | B | 63 | -- | 63 | 0 | | 87 | | 105 |
| 52 | A | 66 | -- | 67 | 1 | | 87 | | 11 |
| 53 | B | 62 | -- | 66 | 4 | | 87 | | 105 |
| 54 | B | 68 | -- | 68 | 0 | | 86 | | 101 |
| 55 | B | 60 | -- | 66 | 6 | | 86 | | 95 |
| 56 | B | 54 | -- | 63 | 9 | | 86 | | 103 |
| 57 | A | 66 | -- | 66 | 0 | | 86 | | 105 |
| 58 | B | 66 | -- | 66 | 0 | | 87 | | 103 |
| 59 | B | 65 | -- | 66 | 1 | | 87 | | 112 |
| 60 | A | 66 | -- | 66 | 0 | | 83 | | 94 |
| 61 | B | 58 | 60 | 61 | 3 | | 83 | | 95 |