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An Examination of the Effects of Feedback Type and Regulation Style on Test Achievement and Review Strategy Using Computer Web-based Anatomy Labs with First Year Kinesiology Students

by

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Abstract

The purpose of this study is to examine the effects of feedback type and regulation style on test performance and review strategy. Over the course of one semester. the study participants completed three online. multimedia anatomy labs. Each computer lab contained text and picture instructional content. a practice quiz with feedback and a test quiz for marks. Feedback types included no feedback (NF). knowledge of results (KOR) and knowledge of correct results (KCR). Students randomly received different feedback types on each lab. Participants completed a regulation style survey as well as a pre and post-lab attitude surveys. Results showed no significant differences by regulation style. In the last lab. students who were give KOR feedback performed better on the last quiz than those who received KCR. Participants felt that there was too much material to cover for the time allotted and that it was not always relevant to the course goals. Reasons for these results as well as recommendations for the future are discussed.

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List of Abbreviations

AUC – Answer Until Correct

CAI – Computer Assisted Instruction

CBI – Computer Based Instruction

CBT – Computer Based Training

CE – Corrective Efficiency

ES – Effect Size

KCR – Knowledge of Correct Response

KNES - Kinesiology

KOR – Knowledge of Results

NF – No Feedback

SD – Standard Deviation

INTRODUCTION

Students' experiences and attitudes, the skill of the instructors, and the material being studied are three components of the educational environment. The students use the material and interact with the instructor to make meaning of the new information in a way that is influenced by their own knowledge. In order to gain understanding from these new concepts, students need feedback about the correctness of their conceptions.

Post-secondary institutions are increasingly exploring the use of computer-mediated delivery as a supplement to classroom based instruction (Cote, 1998). In this type of situation, the computer-mediated environment provides information to the students in the form of text, graphics, video, animations, sound or some combination of these. In some classes, where the computer-based material is supplemental to the classroom, providing additional information may be its sole purpose. In other situations, the students may then be provided an opportunity to practice new skills using the information. Following a practice opportunity, the computer may assess the students.

Short answer, multiple-choice and matching questions are the most easily assessed by the computer (Salisbury, 1988). In addition, some interactive courseware can assess if students match items by dragging and dropping them on the screen with the mouse or clicks on "hot spots" on the screen with the mouse. Open-ended questions are more difficult to assess using computers, although computers may serve as communication devices to send such open-ended responses to an instructor to mark. They may also provide some data for further analysis. Email, bulletin boards and listservs are a few of the ways that computers can "mediate" the marking of open-ended questions. Closed question types, which assess factual or intellectual skills, are well suited to a computer-mediated environment.

The dynamics of the learning interaction change when students receive feedback from the computer. Azevedo and Bernard (1995) suggest that when teachers provide feedback in a face-to-face session with students, they can make appropriate changes to the information. Instructors can re-word the information, add more information, and ask probing questions to elicit a response from the students. In order to emulate such an environment, instructional designers need to understand the mechanisms by which feedback works so that feedback in courseware can provide students with the required information.

While some studies have shown that feedback is more effective at raising students' achievement than no feedback, there has been relatively little conclusive research to indicate what type of feedback leads to the greatest improvements in students' achievement. This study will examine three feedback types and three regulation styles in order to see which is the most effective at increasing students' achievement and what factors influence students' choice of post-feedback strategies.

CHAPTER 1 - LITERATURE REVIEW

Examples of feedback

Feedback provides an organism with information about the consequences of behaviours taken. In an educational context, feedback provides the students with information about how well they are performing tasks expected of them. In a practice situation, students perform some sort of behaviour in order to learn something new. This may be a cognitive activity such as recalling a fact or analyzing a problem, a psychomotor skill such as hitting a ball or dissecting a muscle, or displaying a behaviour that indicates a changed in attitude or value. Regardless of the type of activity, once the students have performed the behaviour, they need to know whether or not they performed correctly. Feedback in the educational context can be defined as "any of a series of procedures that are used to inform a learner about decisions he/she has made so that the decision can be modified or other decision taken if necessary (Katz, 1984)".

History of Feedback

There is some experimental support for the notion that feedback increases students' achievement and improves their attitudes towards instruction. In a meta-analysis of the effects of feedback in computer based instruction (CBI), Azevedo & Bernard (1995) found that achievement outcomes were greater for students who received feedback than those who had not received feedback in an immediate posttest. Clariana (1992a) also found that any type of feedback is more effective than no feedback for increasing achievement.

The mechanism by which feedback works is not fully understood. Early research studied feedback as reinforcement. According to this theory, feedback had no effect on correcting errors, but merely strengthened the connection between stimulus and correct responses (Mory, 1992). The theory could not explain how an organism could change based on negative responses. As information-processing mechanisms for feedback were proposed, studies began to show that students used the information provided in feedback to correct their mistakes in subsequent performances—countering previous studies in the area (Mory, 1992). Other cognitive and affective processes such as commitment to a goal influence students' use of feedback information (Schutz, 1993). The process by which learners go from making an incorrect response on one test to making a correct response to the same or similar question on a subsequent test needs to be investigated.

Types of Feedback

One area of feedback research examines the amount and type of information that is provided. Kulhavy & Stock (1989) proposed two levels of information in feedback, labelled verification and elaboration. At the verification level, the students are informed whether their initial response was correct or incorrect—but does not provide any further information. The students know how well they performed, but are not given any information about why they performed poorly. Elaboration level feedback provides the learners with much more information in response to an incorrect answer.

Although Kulhavy and Stock identified the two information levels, verification and elaboration, many researchers further subdivide the Elaborations category into two, more specific categories as operationalised by Schimmel (1988). These subdivisions of

Elaboration have been labelled Knowledge of Results (KCR) and Elaborations. KCR refers to feedback that tells whether the answer is right or wrong and if wrong, what is the right answer. Elaboration level feedback includes additional information such as guided 'hints' that the learners can use to arrive at the correct answer themselves, the rationale for the right answer or a review of the problem solving that the students should use to arrive at the correct answer. This paper will employ Schimmel's three-category separation of KOR, KCR and Elaboration in its review.

Learning without Feedback from an External Source

In order to fully understand how feedback works, it is necessary to examine how people learn when no feedback is provided from any source other than the student. Ohlsson's (1996) model of learning describes how people learn from their mistakes when feedback is not provided. In this model, learners detect errors in their performance by comparing actual outcomes with expected outcomes. Learners have an expectation of what will happen when they perform an action. When a mistake has been committed, the actual outcome differs in some appreciable way from what the learners were expecting. In this situation, learners must determine what aspect of their actions was incorrect, and then decide how to correct the error.

Ohlsson (1996) stated that to identify which aspect of the action was incorrect, learners must determine which features or patterns of features indicate that an incorrect action was taken. These features are referred to as error signals. In order to recognize the error signals, the learners must have knowledge specific to the domain of performance. In the absence of other resources, the learners' prior knowledge about the domain is their main resource for judging whether the situation that they encountered is promising or problematic. Gagne (1965) specifies that this prior knowledge is related to the recall of previously learned principles. According to Ohlsson (1996), learners often have weakness in their knowledge base due to the newness of the concepts. By removing faults in the underlying knowledge base. learners can improve the probability of not making the same error in the future.

Ohlsson (1996) believes that faults in the knowledge base can be traced to applying overly generalised rules to situations. without taking into account the specific features of the situation. With time and experience. learners begin to add specific exceptions to each rule. These exceptions are often in the form of representative examples and situations, which forms a set of conditions under which the rule is not true. As learning continues, the conditions side of each rule becomes more specialized and the rule becomes active in fewer situations. Unfortunately for the students. learning a new exception to a rule does not always correct all errors. The old. more generalised rules are still in memory, and occasionally displace the newer and more correct rules that have been restricted with exceptions. As each rule for a task becomes more specialised. the entire task will be mastered.

Gagne's (1965) theory of learning doesn't refer to faulty knowledge base, but rather the lack of contiguity in the principles required for problem solving. For contiguity to occur, all of the principles required to solve the problem must be held in the mind at the same time. This contiguity is more likely to happen when the relevant principles have been recalled recently. Once the problem has been solved, new principles will be formed.

These 'principles' are parallel to the 'rules' referred to by Ohlsson. While Ohlsson believes that errors occur due to missing rules or principles, Gagne believes that errors may occur even though a student knows all of the rules/principles. Even if a student once knew a rule, it's possible that they may be unable to recall the relevant item when required. Access to domain specific knowledge is essential in both learning theories.

Steps to Rule Specialization

Ohlsson (1996) describes a three-fold process through which rules become specialized. Initially, the students must recognize which rule involved in a complicated task is the one that needs to become more specialized. "Blame assignment" is the term used to describe the process of identifying the incorrect action and hence which rule has been applied in error. Once the faulty rule has been identified, the learners must determine precisely what is wrong with the rule. This requires the identification of some feature of the current action that they performed which produced the undesirable outcomes. This step is called "error attribution". Following the identification of the feature that makes the rule not applicable, the rule must be augmented with an exception statement that excludes situations in which a certain element exists. The addition of information modifies the knowledge base and reduces the probability of repeating the same error. Ohlsson (1996) concludes that if people learn from their errors, they must carry out the functions of blame assignment, error attribution and revision of faulty knowledge structures (or rules). As rules are gradually specialised, the accuracy and speed of decisions are improved.

From a teaching-learning perspective, much iteration is required to refine this rule modification process. The strength of this method depends on the students' ability to discern if a situation is problematic. Most students do not have the background knowledge to know whether or not their responses are accurate. It can be difficult for students to identify the exact aspects of a situation that make it an exception to the rule. To discern and correct their mistake, the students must use a trial and error approach. While this may encourage engagement with the material, it is neither efficient nor effective. Students may not realize all of the options in their trial and error; effectively reducing the chance that they will perform correctly. It may be a lengthy process to try all of the alternatives. In addition, some tasks, such as programming, result in a clear indication whether the procedure has worked or not, while other tasks may make it more difficult for students to know if they produced the correct response.

Features of Effective Feedback

According to Ohlsson (1996), effective feedback should refer to the situation in which the incorrect action was taken. By taking on the role of blame assignment, the feedback quickly indicates what aspect of the students' response is faulty. Feedback should also specify the conditions under which the actions taken are correct or incorrect. In other words, feedback should identify the exceptions to the rule that make the application of the generalized rule a mistake in that particular instance.

Relevance to Mediated Feedback

In situations where the computer provides feedback about errors, blame assignment is reduced to identifying the action performed immediately before the error as the incorrect one and whatever rule it invoked was the faulty one. Blame assignment is very easy in computer based training (CBT), since the material provides the information necessary to identify which action (usually an answer to a question) is faulty.

Error attribution requires the students to identify what is wrong with the rule they used to generate an answer. To do so, they must identify what aspect of the question is causing them to apply the rule incorrectly. KOR never specifies the conditions under which the rule applied was correct or incorrect, since it provides no additional information. If students review the lesson, they might be able to attribute the error to the part of the question where they applied a rule incorrectly. Both KCR and Elaborative feedback provide additional information that can help students identify which part of the question caused them to invoke an overly generalized rule.

Empirical studies of what people are thinking when they detect errors are not readily available, according to Ohlssen (1996). However, what people *do* between error attribution and subsequent performance can be examined. The behaviours that are evident between blame assignment (KOR), error attribution (KCR and Elaboration) and subsequent performance will be examined further in the review.

Learning from Feedback

Kulhavy and Stock (1989) have proposed a three-cycle model that describes how feedback corrects error in a learning environment. According to Kulhavy and Stock, feedback consists of information about whether the answer is correct or incorrect as well as more detailed information. This model is written as:

Feedback = Verification (match OR mismatch) + Elaboration (Type, Form, Load).

During Cycle I of the model the learners perceive a stimulus, in the form of a question, and compares it to information contained in the prior knowledge base. The knowledge base is composed of previous experience (Do I generally perform well on this type of task?) and semantic content information (Do I understand the material well enough to perform correctly?). The combination of these two elements forms an internal reference standard. The students evaluate various possible responses to the question from the knowledge base. A judgement is made between the question and the possible response, to see how well they fit together. Each alternative response will be assigned a degree of expected correctness based on how congruent it is with information in the knowledge base. The students continue to evaluate alternative responses until all of the comparison possibilities are exhausted or the allotted time has been used up. Once the evaluation stops, learners produce the response that they are the most certain is the correct one. This measure of certainty is called certitude. The response and its associated certitude are stored in memory.

During cycle II, learners compare their response and its certitude with the feedback generated by the system. If the learners' initial response to a question is incorrect, they will exert some effort to resolve the discrepancy between their response and the correct answer. For example, students will spend more time studying feedback following errors than following correct responses.

In Cycle III, when students are expected to perform on a post-test, they compare the questions (stimulus) against their new, changed knowledge structures (modified based on feedback), to produce answers to the test items. If learning occurred, there should be less discrepancy between Cycle I and III stimulus and referents.

Kulhavy and Stock (1989) propose that the way in which feedback influences a learners' behaviour is measured by the type and extent of the behaviours that follow the presentation of feedback. They suggest that feedback research has focused on the change in learners' response from practice test items to post test items but has bypassed the evaluation of behaviour following feedback. They feel that further research must target the learners' behaviours following the presentation of feedback if insight is to be gained into the way in which feedback operates on the human system.

Bangert-Drowns, Kulik, Kulik and Morgan (1991) agree with the basic model of feedback presented by Kulhavy and Stock (1989). Based on a meta-analysis, Bangert-Drowns et al (1991) propose a model that suggests that initially learners come to the instruction with initial interests, goals, degree of self-efficacy and degree of prior relevant knowledge. During or after instruction the learners are given questions, which cause them to activate strategies that examine their prior knowledge base. After examining their knowledge, the learners respond to the question with some degree of certainty and with some expectation about what the feedback will indicate. In light of information given in the feedback, the learners examine their response and makes adjustments to relevant knowledge structures, self-efficacy, interests, and goals. The adjusted states determine the next initial state.

Kulhavy and Stock (1989) would argue that response certitude mediates how much attention learners pay to feedback and whether they use it to change their knowledge structures. However, four studies included in Bangert-Drown et al's (1991) meta-analysis found no clear relation between certitude, confirming or disconfirming feedback and post-test performance.

Effects of Feedback

The effects of feedback have been mixed in the research literature. Although some studies have shown no effect for feedback (Clark & Dwyer, 1998;White, Troutman & Stone, 1991: Chen & Brown, 1994), other studies have shown that any type of feedback is superior to no feedback for increasing students' post-test achievement (Huang, 1995; Azevedo & Bernard, 1995; Clark, 1992a). A majority of studies also seem to indicate that KCR or Elaborative feedback is superior to KOR feedback for achievement (Lee, 1991; Bangert-Drowns, Kulik, Kulik & Morgan, 1991). Contradictory results have been found for KCR versus Elaborative feedback. Some studies show a significant difference (Pridemore & Klein, 1993; Farquhar & Regian, 1994; Lee Kim & Phillips, 1992), while others have found no-significant difference between KCR and Elaborative feedback (Bangert-Drowns, Kulik, Kulik & Morgan, 1991; Huang, 1995; Clark, 1993). The following studies illustrate these effects.

Huang (1995) conducted a study in which the relationship between students' attitude and achievement was examined with regards to no feedback, KCR and Elaborative feedback as well as prior knowledge in the content area. Students were given computer-based training material that covered terminology and concepts for weight training. Feedback followed the practice questions. The posttest was two weeks after the learning sessions. Students who received KCR or Elaborative feedback had higher posttest scores than those who received no feedback. No significant difference was found between the KCR and Elaborative feedback group.

Lee (1991) conducted a study to examine the effect of KOR, KCR and Elaborative feedback. A CAI module on the BASIC programming language was designed to include an introduction to programming variables with examples and practice questions. The module was followed by a set of 5 multiple-choice questions. It is not clear from the study, at what level of complexity the practice questions were written. Feedback was provided only after all the practice questions for the three modules were completed. Results of the study indicated that students who received Elaborative feedback had significantly higher immediate posttest scores than those who received KOR. Due to the small number of test questions, the reliability of this study may be suspect.

In a meta-analysis of feedback studies, Bangert-Drowns, Kulik, Kulik and Morgan (1991) found that feedback type had a marginally significant relation to effect sizes. Feedback had an effect on achievement (0.46 standard deviations). When learners were told only if an answer was right or wrong (KOR), feedback had virtually no effect on achievement (ES = -0.08). When they were given the correct answer or were provided with guidance (KCR and Elaborations), the average effect of feedback was higher (0.31 standard deviations). The meta-analysis did not indicate whether the students were allowed to review the material between practice and post-test, an important consideration that will be examined further in this review.

It is difficult to ascertain whether there are any significant differences on students' achievement between KCR and Elaborative feedback. Bangert- Drowns et al (1991) found no relationship between the amount of information (load) and the effect of feedback for KCR and Elaborative feedback.

Pridemore & Klein (1993) conducted a study with 126 undergraduate education students. Subjects completed a CAI program on statistical reliability and validity in which they read text, answered embedded practice questions and received feedback. A 2x3 design was used in which treatments groups included learner control vs. program control as well as KOR, KCR and Elaborative feedback. Students who received Elaborative feedback performed only marginally better than those who received KCR feedback. Huang (1995) also found no significant differences between the KCR and the Elaborative feedback groups.

Clark (1993) found no difference between groups that received KCR or Elaborative feedback. Academically disadvantaged undergraduate students used a computer assisted instructional system to learn about astronomy. Five screens of text were followed by five multiple-choice questions. Students were presented with either KCR or Elaborative feedback. No significant difference in posttest score was observed.

Other studies have found a significant difference between KCR and Elaborative feedback. Farquhar & Regian (1994) examined the acquisition of procedural knowledge through the use of immediate and delayed feedback. Subjects completed a computer-based tutorial in which text and graphics described a task. Following the tutorial, students where given a set of practice problems. Students either received feedback directly after each question or delayed until the end of the practice session. Results indicate that Elaborative feedback was more effective than KCR feedback when it was give directly after each question. No significant difference was evident when the feedback was delayed.

Lee Kim & Phillips (1992) conducted a study with adults in an informal education setting. Participants were shown a video on diabetes control followed by a set of multiple-choice questions. Participants were expected to apply the information learned in the video to the management of their own diabetes. One group was given KCR feedback; the other group received Elaborative feedback. The participants who received elaborative feedback had significantly higher test scores than those who received KCR feedback.

It seems clear from the research literature that there is a continuum where increasing amounts of information in the feedback leads to greater post-test results. This observation seems to apply to no feedback, KOR and KCR feedback. In the two cases where Elaborative feedback was more effective than KCR, learners were expected to correctly order procedural tasks. For higher order thinking skills in which the students must solve unique problems, perhaps the additional information in Elaborative feedback would produce higher achievement. In settings where the students' tasks only require recall of memorised information or re-statement of concepts, KCR feedback may be just as effective as Elaborative feedback.

Factors that Influence Review Strategy

In previous studies cited, the students' post-feedback learning strategy was not measured. In some of studies, the students were not given the opportunity to review. The studies that found KCR was more effective than KOR did not let the student's review the material between the practice and posttest. In other studies, even though a time interval existed between practice and post-test, students' behaviour during the interval was not observed. Roberts (1996) conducted a study to determine what students do with feedback received on distance learning materials. Of the 22 students interviewed, 5 claimed to have only read the feedback, but did nothing else. The majority (numbers not given in text), claimed to use the feedback to carry out follow-up work such as re-reading and re-thinking the relevant sections of the study material. Given that students review, the factors that influence their choice of a review strategy when there is a time interval between practice and posttest should be examined. Since very little research has focused on student's behaviour following feedback, these questions are of interest in the present study.

Amount of Information in the Feedback

Assuming that students are motivated, poor performance should result in an effort to use the resources available to improve their performance. In situations where students are not given the opportunity to review additional learning material between practice and posttest, the additional information must come from the load in the feedback. In these cases one could speculate that students who received relevant information feedback would perform better on the posttest, followed by decreasing levels of information in the feedback.

This trend seems to be evident in the literature, where most of the studies that showed Elaborative and KCR feedback to be more effective than KOR did not let students review the material between the practice and the post-test. Morrison, Ross, Gopalakrishnan & Casey (1995) conducted a study with students in an undergraduate teacher education class that compared three feedback and two control strategies. Students completed a unit on instructional objectives using computer-based instruction. Half of the students completed it as a part of their regular course and half completed the unit external to the course. Both groups received course credits for participation. Within these two groups, students were further randomly assigned to one of five feedback conditions: KCR, AUC, Delayed KCR, no feedback or no questions. Students who received delayed KCR received knowledge of results (KOR) directly after each response and KCR feedback after the entire unit was completed. The AUC condition provided a right/wrong response and the option to review the material. If the student answered incorrectly, the question was repeated until the student answered correctly. This was repeated up to 8 times per question. The no-questions category was used to provide a control group. Students were given the material to read and provided the opportunity to review, but were not asked any questions about the material. Those students who received KOR after each question chose to review the material more frequently than students who received KCR feedback after each question.

Clariana (1992a) conducted a study with 100 eleventh grade students who completed 5 weeks of computer-based instruction. The study design consisted of two conditions of instructional support (text and questions vs. question only), two testings (immediate vs. delayed), five levels of similarity between lesson and post-test questions and five feedback conditions: KCR, KOR immediate + KCR delayed, AUC, no feedback, and no questions. Students who received the instructional support were provided with instructional text while they were completing the test. No guidance for use of the instructional text was provided. Some students read the text before answering the questions; some referenced it while completing the test questions and others consulted the text after completing the questions. Students who received the KOR initial + KCR delayed took longer to complete the lesson than students who received the immediate KCR. The study did not examine whether the immediate KOR students made greater use of the supporting text than the immediate KCR students. However, since there would have been less text to read in the immediate KOR condition, and hence less time needed to process the feedback, it is possible that the increase in time spent to complete the lesson by the KOR group resulted from students spending more time reviewing the supporting text.

Pridemore and Klein (1995) conducted a study with junior high students who had completed a computer lesson about the parts and function of a microscope. The students were divided into 6 groups (learner or program control; no feedback, KCR or Elaborative feedback). All computers presented the information text in the same way. After reading the text, the students in the program control group completed 3 mandatory practice questions. Students in the learner control group could choose whether to complete 3 practice questions. Students received no feedback, KCR or Elaborated feedback after completing the questions. Within the learner control group, there were no significant differences between the numbers of questions selected, regardless of the type of feedback received. Students receiving Elaborations choose the same number of practice questions as the no feedback or KCR feedback students.

Incremental feedback is an alternative way to provide feedback. After a question is answered, the feedback tells the student which portion of their answer is correct. The student is given the opportunity to fix the part of the answer that was incorrect. Additional feedback may be given on the corrected portion. In a study conducted by Bilan (1998) using incremental feedback, students attempted to obtain the correct answer on their first attempt. As the content became more difficult, this strategy became less effective and students used the feedback to arrive at the correct answer. As the length of the learning material became lengthy, some students would skip the reading and only complete the questions.

These studies reviewed seem to indicate that the amount of information in both the feedback and the learning material seems to impact how the students used the feedback provided.

Percent Incorrect on Practice Test

Human performance often follows a non-linear curve (Hergenhahn & Olson, 1997). As performance improves, more effort is required to continue the improvement at the same rate. As the number of incorrect responses on the practice text decreases, there may be less motivation on the students' part to pay attention to the feedback. The students may perceive that the relationship between effort and results is not directly linear and hence the amount of effort invested does not always directly contribute to increased scores. However, the decrease in attention may only be relevant if the students' primary goal is to finish the course rather than learn the material.

Hancock, Thurman & Hubbard (1995) conducted a study in which students' use of feedback varied by achievement level. Students were required to select an object on the screen and identify its name. Subjects with the lowest correct test scores tended to spend the least amount of time reading the feedback information. For students in the highest performing group, feedback was studied more when answers were incorrect or when they were uncertain about their answer. In a follow-up questionnaire, students who spent the most time processing the feedback had goals more closely related to learning, rather than just finishing the course.

Variables that Interact with Feedback

Students' ability level appears to interact with their use of information presented in feedback. Bender (1989) conducted a study with undergraduate students in an educational psychology class. The students' quiz responses and a correct answer sheet were provided to students following an exam. Students in the experimental group were told to review anything they answered incorrectly and then find the correct answer in the text and in their notes. They were also directed to review correct items and any items about which they were uncertain. Students in the control group were only told to review their exams until they were satisfied. Results of the study indicate that low ability students performed worse than high ability students on a posttest when both groups received feedback. Bender concluded that although both groups appeared to use the feedback to modify their knowledge structures, that the high ability students were more adept at it.

Regulation Strategies that Inhibit Attention to Feedback

Since feedback is a two way interaction, even the most effective type of feedback may have no effect on increasing marks if students don't take advantage of the information presented. The degree to which students actively makes use of external resources, may predict the usefulness of feedback for learning.

Self-regulation is a construct that has been examined to determine students' orientation towards learning. Self-regulated students are active participants in their own learning. These students initiate activities and will persist until a task is completed. They also will seek out information from other sources and alter their environment in such a way as to optimize learning (Zimmerman & Risenberg, 1994). Students who are more self-regulated tend to ask their instructors more questions in a lecture (Karabenick & Sharma, 1994). This seems to indicate a more active help-seeking behaviour in self-regulated students. Pintrich & Garcia (1994) report that students who exhibit the characteristics of self-regulation, such as planning, monitoring and regulating learning strategies, perform better on achievement outcomes.

Students with a high external regulation score typically rely on the guidance of others to learn new material. The guidance may be in the form of questions that the students have to answer, objectives they have to meet or guidance from the instructor. Self-regulated students may use the guidance provided by other sources, but also rely upon their own activities to meet their learning needs. They may seek out additional reading materials or problem sets. They may pose questions of their own making to determine if they understand the material. Students lacking regulation often do not know what is expected of them and don't know how to find out what to do. They have difficulty processing a large amount of material, lacking the skills to break it into smaller chunks. Vermunt (1987), using a self-created psychometric instrument, found those students who are externally regulated or lacking any regulation strategies were less likely to use any feedback provided regardless of feedback type. The self-report measure used by Vermunt, categorized students into one of the three regulation styles, based on their self perceptions.

Students' ability to judge whether or not they need to review feedback seems inconsistent. In some cases, students can accurately judge their own need to review feedback material. Schloss, Sindelar, Cartwright & Smith (1988) found that students did not always choose to review available feedback. Fifty-two undergraduate students taking a special education class completed two CAI modules. Each module contained 90 information screens and 60 multiple-choice questions. Two thirds of the questions examined higher order thinking skills. The first module provided Elaborative feedback after every incorrect response. In the second module, the students had to choose to view the feedback before it was presented. Results indicate that both high and low ability students scored no better on the posttest when they could choose the feedback than when the feedback was mandatory. Students completed the modules with optional feedback more quickly than those with mandatory feedback.

In other studies, students have not been as accurate at identifying their need for feedback information. Pridemore & Klein (1993) conducted a study with 126 undergraduate Education majors. They found that students who were given mandatory or "program control" feedback spent more time studying feedback than those who were given optional, "learner controlled" feedback. In addition, students who received program-controlled feedback outperformed those who had the option to review the feedback. This conflicts with Schloss et al (1988), indicating that all students may not be equally equipped to diagnose their need to review feedback material. Some students, such as the ones participating in Schloss's study, may be adept at judging whether they understand the material and need to review. If the scores for mandatory and optional review modules are the same, and students can move through the optional feedback module more quickly, then this may indicate that they are skipping the feedback when it is unnecessary. Students may also be lacking in self-regulation, which inhibits them from taking responsibility for their own learning. Regulation strategies will be examined further in the review.

Student reliance on external factors for guidance can create a dilemma for the university educator. At the 1st year level, most introductory classes within a discipline have a standard set of topics that are covered. This consistency provides students with the necessary pre-requisites to continue with higher-level classes. On the other hand, the university instructor is aware that they must graduate students who are self-regulated problem solvers. Pintrich and Garcia (1994) suggest that although educators from K – 12 also desire to shape students to become more self-directed, that college students are more developmentally ready to attain self-regulation. They also maintain that college students are more in need of self-regulation strategies because of the complex environment of post-secondary education in which they have more choice and control. Within formal learning institutions, Caffarella (1993) identified that the willingness and ability of the learner to create their own direction, the content to be learned and the situational context will influence the amount of self-direction that the learners seek and the instructors will allow.

Lack of Motivation as Inhibitor

Motivation may also be a factor that impacts how well students utilize feedback. According to Keller (1988), the essential elements of motivation are attention, relevance, confidence and satisfaction. For students to remain motivated throughout the learning session, the material must be relevant to their goals, inspire confidence in their abilities and satisfy their reasons for learning. According to the theory of situation motivation, tasks should be moderately challenging (Paris & Turner, 1994). Activities that are too easy or difficult leave the student either frustrated or bored.

Corrective Efficiency of KOR vs. KCR feedback

Both Ohlsson (1996) and Kulhavy and Stock (1989) postulate that learning occurs when the knowledge base and the rules for its application are changed. To modify the knowledge base, students need information about what items were wrong and why they were wrong. When students receive no feedback, they don't receive either type of information. If they receive KOR, then they know what answer is incorrect, but they don't know why it is incorrect. When they receive KCR feedback, both of the factors that comprise feedback are available to the student. Students may choose to review additional material even if they receive some information in the KCR feedback. However, students who received KOR feedback must review the lesson in order to received adequate information to modify their knowledge base.

Although additional review is always desirable, students may feel that the time invested will not necessarily result in a large enough test score improvement. To achieve the most efficient revision of faulty rules, the students should answer all of the items on the test correctly with the least time invested. Efficiency for each level of feedback has been measured by dividing the posttest score by the amount of time invested (Mory, 1992).

Efficiency = Score/Time

In a survey of the literature, Mory (1992) reported that where time spent reading the text prior to examination was the denominator no significant differences were found. In studies where the amount of time spent reading the feedback was measured as the denominator, results showed that feedback with less load was more efficient.

Only using feedback study time as a denominator ignores the students' response to feedback after the test. Two factors must be considered when calculating corrective efficiency for feedback by review between practice and posttest. One factor mentioned by Mory (1992) is the time required to read the feedback during the exam. Dempsey, Litchfield & Driscoll (1993) found that KCR takes less time to study than KCR plus more elaborative information. Pridemore and Klein (1993) conducted a study in which 126 education undergraduates were divided into 6 groups. Variables studied included learner or program control and three levels of feedback (verification, KCR, or

Elaboration). Students who received elaboration feedback took the most time to study the feedback given, followed by KCR. Students who received verification spent the least amount of time studying the feedback. Finally, Clariana (1992) conducted a study in which students were provided with full or focused feedback. Full feedback included the stem, distracters and correct answer to the multiple-choice question (similar to Elaborated feedback). Focused feedback included only the stem and the correct answer (Similar to KCR feedback). Students took more time to complete the reading and questions when they received the focused feedback. One of the assumptions of the study was that students read the material at the same speed, eliminating individual differences in reading speed.

In addition to the time spent reading the feedback during the exam, students must also include the time reviewing the material between practice and posttest. For students who spend little or no time reading the feedback, a review strategy will have the highest return on test score for every unit of time invested. In cases where there is little information in the feedback, it is possible that students may invest greater time in reviewing the material. Conversely for those students who receive a greater information load, review may not be the most efficient strategy.

Based on the literature reviewed, one can derive a mathematical formula to examine the corrective efficiency of Review x Feedback Type. CE represents the corrective efficiency in both formulae. In the first formula, the corrective efficiency is measured according to time spent on the system. For optimal efficiency, the students should spend the least amount of time on the system and have the greatest improvement from practice test score to posttest score.

$$CE_{(\text{Feedback Type x Time on System})} = \frac{\text{(Total correct answers on posttest - Total correct on the practice test)}}{\text{(Time on system after practice test + time to complete practice test)}}$$

If KCR students spend more time reading the feedback during the practice test than either the KOR or no feedback group, but less time reviewing, then there is likely no increase in learning efficiency. When the time invested merely shifts to a different part of the feedback cycle but is not actually lost or gained, then increased efficiency for the students may not be a realistic goal in the design of instruction.

It is important to know if there is a difference in student performance based on feedback type. If students' perform better with a certain type of feedback, then it is important to create learning activities that utilize that type of feedback. If there is no significant difference between feedback types, then the efficiency of course development could be a factor in the type of feedback that is used. KOR and KCR levels of feedback are not equally time intensive to create. Indeed, KOR takes much less time to design and develop since it includes less information than KCR or Elaborative feedback. In the case of computer-mediated feedback, mixed results make it difficult to decide on appropriate courses of action for designers and students.

Use of Feedback in Computer Assisted Instruction

Use of feedback is not restricted to classroom-based, instructor-led learning environment. The use of computers to augment the teaching/learning experience means that we must investigate not only the optimal types of feedback in general, but also the effect that using computer-mediated delivery might have on feedback. Student preferences for feedback delivery should be examined as well as the benefits and potential drawbacks to computer-delivered feedback.

Students' preferences over the method of feedback dissemination are varied. In some situations, students perceived that when the instructor administered feedback that it was more personalised and included extra information that the computer did not provide. Dwyer & Sullivan (1993) conducted a study to investigate students' preferences for computer marked and instructor marked written compositions. Students' correct use of grammar in composition was evaluated. Eighty-seven percent of the students indicated a preference for instructor marked assignments, although over 85% indicated that they liked using the word processor and that it made writing easier.

Croy, Cook and Green (1993) also found that students preferred feedback that was provided by the instructor. In this study, students constructed logical proofs on a sophisticated computer program. The computer assessed their performance and generated recommendations. One group of students received the computer-generated information on a printout and the other group was presented the same information by their instructor in an individual meeting. Students who received the computer-generated feedback from their instructor had higher exam scores than those who received the printout only. The researchers concluded that since students could ask the instructor questions about the feedback, that they received an advantage and hence the differences in test scores. Other research suggests that some students who receive computer-mediated feedback are more likely to seek subsequent feedback than are those who received feedback from a person. Ang & Cummings (1994) examined feedback-seeking behaviour in 72 undergraduate students. Students were given a simulated business memo to read followed by a multiple-choice question. Students could choose whether or not to receive feedback after each question. Based on the treatment they received, students could access feedback from a person directly, use email to receive feedback from the same person or receive computer-generated feedback. Subjects sought more feedback when it was computer generated than when the person delivered it directly or through email.

Roberts (1996) interviewed 22 students about their perceptions of feedback. Students were asked what they thought constituted effective feedback. The most common response was that feedback explained specifically where the students were incorrect and provided model or correct answers and the reasons why those answers were correct. Students thought these were important elements for feedback, regardless of whether the feedback was provided by a tutor or a computer. Students thought that the strength of computer marked assignments was that it included comprehensive, detailed feedback that was well organized and structured. The computer also gave them the correct answers and the students perceived that it was clearer how the answers were determined when the computer provided it. On the other hand, students felt that the strength of tutor feedback was that it provided positive and encouraging remarks.

In a study conducted by Grabinger and Pollock (1989), students performed better on a procedural task when feedback was provided by an expert system than when provided by teaching assistants. The researchers concluded that the expert system provided the students with all of the information required, while the teaching assistants often concentrated on a limited set of information. The feedback generated by the computer system was provided more quickly and was less threatening.

The research seems to show that students have varied responses to feedback delivery by computer. When doing tasks that require unique responses, such as creative writing or creating computer programs, students appear to prefer the flexibility offered by instructors. In cases where the feedback involved set procedural steps, students appear to prefer computer-mediated feedback.

Research Benefits of Computer Mediated Feedback

One of the benefits of using computer-delivered feedback is the ease of data collection which enables researchers to examine what pages the students view, what order, how many and for how long each page is viewed (Misanchuck & Schwier, 1991). Although a general trend can be seen in terms of the types of feedback that are the most effective, there is very little data on what students do after receiving feedback. Some students may choose to review the material again, while others may not. In an educational setting where the information is delivered by tutors or printed text, it is difficult to determine what actions students take as a result of receiving feedback. When all of the necessary information is presented on the computer, it is possible to track students' behaviour after receiving feedback. Use of an audit trail may provide data on what pages students view and how long they spend in the different parts of the application.

Computer Anxiety as Inhibitor

One of the potential downsides to using computer-mediated feedback is that some people experience stress from using technology. Weil and Rosen (1997) describe techno-stress as being "any negative impact on attitudes, thoughts, behaviours or body physiology that is caused either directly or indirectly by technology." Studies have found that continued exposure to computers in a variety of tasks alleviates some anxiety and allow for a greater degree of comfort for those that are anxious about computers. Perkins (1993) found that students who reported any one of the following types of experience (word processing, database programs, desktop publishing or computer programming) for at least a year had less computer anxiety than students without any experience or less than a years experience. Programming (Liu, Reed & Phillips, 1990) and word processing can both reduce student's anxiety with computers (Busch, 1995).

Teaching Online

Web based training is the latest computer mediated learning tool to be investigated for classroom use. Researchers have investigated student response to this relatively new way to mediate learning. Anderson and Joerg (1996) found that students report both benefits and trials to using the World Wide Web as a supplement to classroom instruction. Benefits of include greater access outside of class to materials, greater ease of revision by instructors and reduction of paper waste. Negatives cited for using the Web include problems with access due to restrictions on connectivity speed and the inability to annotate materials online.

Premkumar and Baumber (1996) found that anatomy students are increasingly requesting the use of multimedia materials in their learning. In their study, medical students heavily utilized a centralized learning resource centre when taking the Musculoskeletal portion of their course work. Students felt that computer programs for learning medical concepts were very useful and requested more interactive computer programs to assist in their study.

Research Questions

This study will look at the effectiveness of KOR and KCR feedback and the post feedback strategies that students use to modify their knowledge base in a series of web-based, online anatomy labs. It will also examine whether students choose the most efficient strategy when completing the online content tests.

The following predictions will be examined in this study:

- Students will perform better on tests when they receive KCR and KOR, than on tests where they do not receive any feedback.
- Students who receive KCR will have higher posttest achievement scores than those who receive KOR.
- There will be a difference in the amount of review chosen between the no feedback, KOR and KCR feedback conditions.
- There will be a relationship between practice test score and how much review is chosen.

- Students with a self-regulation profile will perform better than those with an external or no-regulation style, given the same type of feedback.
- There will be a difference in corrective efficiency for KOR and KCR feedback.

CHAPTER 2 - METHODOLOGY

Participants

The participants for this study consisted of students enrolled in the Fall 1999 course offering of KNES 261 at the University of Calgary. Of the 254 students registered in the class, 115 consented to participate in the study. Students were involved in four computer laboratory sessions utilizing the Functional Human Anatomy Courseware. Specifically, students were required to use the anatomy information presented in a net-based computer environment and complete on-line tests relating to their understanding of the information presented. All of the students who were enrolled in the class were required to participate in the online labs. Course marks were assigned to computer lab component completion, however; only those students who voluntarily consented to participate in the project completed the survey instruments. Students had access to the material through open lab times as well as from home if they had fast Internet connections (ie. cable).

The consent form which students signed is provided in Appendix A. Each participant was given two copies of the consent form describing the project and given one week to read and return the consent form. The second copy of the consent form was provided for the students' own records. Students were required to provide background information on pre-lab and post-lab questionnaires, agree to the use of the questionnaire information in data analyses and written reports, and permit data related to quiz performance to be collected, analyzed, and used in written reports. Whether or not students chose to participate, no information of their consent was available to the instructors.

Materials

Computerized Anatomy Labs

The computerized anatomy labs were designed using web based resources and were composed of two components. The functional anatomy portion was designed and developed by the faculties of Kinesiology and Medicine at the University of Calgary. The dissection portion was created by Gold Standard Multimedia (city, state), a commercial software publisher. For screen shots and explanation of each section of the program, see Appendix B.

Computer lab 1 contained an introduction to the online labs. It described the labs and gave students an opportunity to practice using the material. Study strategies were provided. Labs 2, 3 and 4 covered a portion of the human body. Lab 2 covered the upper extremity, lab 3 covered the lower extremity and lab 4 covered the torso. Each lab consisted of five components: Introduction, Surface Anatomy, Dissection, Movement and Testing. Testing consisted of a practice quiz and a quick for marks.

Survey Instruments

Before completing the computer lab component, volunteer students received a pre-lab questionnaire (Appendix C). The questionnaire covered demographic information (e.g., gender, major, year of study), as well as their computer skills, use of email, Internet and word processors, and confidence in the course.

The self-regulation inventory (Appendix E) is a published psychometric instrument that measures three factors: External Regulation, Self Regulation and Lacking Regulation styles (Vermunt, 1987). Based on students' answers they were categorised into either an externally regulated, self-regulated or non-regulated style. Cronbach's alpha given for the scales in Vermunt's study (1987) is: External (a = .80), Self (a = .81) and Lacking (a = .71)

After finishing quiz four, volunteer students completed a post-lab questionnaire. The questionnaire (Appendix F) gathered information from students about the following areas of the computer lab component: usefulness, satisfaction, visual design and navigation as well as perceived skill and comfort with computers. The information from the questionnaires, along with information from the six quizzes (3 for practice, 3 for marks), was recorded.

Procedure

General Description

Each of the 254 students enrolled in the course was assigned to a computer lab section that met once a week for two hours. Students were evenly divided into groups, with a maximum of 25 students per computer lab section. Each study participant was assigned a participant identification number, separate from his or her University of Calgary student number. All information collected for the purposes of this study used this participant identification number, rather than participants' University of Calgary student number. The computer assigned each participant a conditions sequence indicator, which identified the order in which the different feedback conditions would be presented to each student.

Each student received one type of feedback per computer lab component. After completing 3 labs, they would have received each type of feedback (no feedback, knowledge of results (KOR), knowledge of correct response (KCR)). For example, student A might have received knowledge of result on the first quiz, corrective feedback on the second quiz, and no feedback on the final quiz, while student B might have received no feedback on the first quiz, corrective feedback on the second quiz, and knowledge of results on the final quiz. The order in which students' received the different feedback conditions was balanced across the group.

Students completed a practice quiz and a test quiz for each of lab 2, 3 and 4. The first quiz provided students with one of the feedback conditions (dependent on the computer assigned conditions sequence indicator) but did not count towards the student's course grade. The second quiz did not provide any feedback and did count towards students' course grade. In total six quizzes were used.

Introduction to the Computer Lab Component

Students were directed to complete Lab 1 as an introduction to the software and a tutorial for using the package. Components included how to search for health related information on the World Wide Web, how to find their teaching assistant's contact information, and how to access both the Functional Anatomy and Dissection portions of the program. Suggested learning strategies for making the best use of the computer labs included making notes and sketches of anatomical structures, making connections between the material presented in the labs and the lectures, collaborating with peers, reviewing material related to feedback provided, and following the tutorial instructions. A human figure was provided which showed the anatomical terms for the different regions of the body.

Students were expected to use the assigned lab times to work through the material in the computer labs. They also had access to the material during open lab times and from outside locations if they had high-speed connections. Although the students were free to look at all portions of the program, they were only expected to complete the lab that was being currently covered in the lectures.

Research Design

A modified crossover design was used in which every participant received every treatment across the computer lab components. The independent variable, feedback, was separated into three levels (no feedback, KOR and KCR). The no-feedback level did not provide any information to the learners. In the KOR level, learners were told if their answer was correct. In the final level, KCR, learners were given an explanation of why each of the multiple-choice options was correct or incorrect and information on how to arrive at the correct answer. The order in which students received the treatment (no feedback, KOR or KCR) was randomized across the labs. By the time the students had completed all three labs, they would have received all feedback conditions. The lab in which they received each feedback type was randomized. Benefits to the crossover design include ethical considerations. No students were any more disadvantaged than their peers due to not receiving feedback. Gender and regulation style were also examined as an independent variables. Students' performance was measure by their practice quiz and test quiz scores as well as the number of pages they reviewed between the practice quiz and test quiz.

Data Collection

Data was collected on-line during the anatomy lab in a computing facility within the Faculty of Kinesiology. In the computer lab. students would log into to the computer system by providing their own personal user name and password. Data collected consisted of participants' responses to the on-line pre-lab. regulation style and post-lab questionnaires. and their performance on the six quizzes. An audit trail was kept in which the pages viewed and the amount of time to view each page was recorded. Students did have the option of accessing the online labs at other times and locations and that data was also collected by the system.

Analysis

Frequencies. means and standard deviations were conducted on the demographic data such as gender. age and academic major. A factor analysis was conducted on both the pre and post questionnaires in order to reduce the 30+ items on the questionnaires to a manageable set of variables for analysis as well as identify the items that are inter-correlated. A principle component analysis with a varimax rotation was conducted on both instruments. Varimax rotation was chosen because it will maximize the variance explained by each factor (Norman and Streiner. 1997).

Correlations were conducted on the relevant interval/ratio variables. including the pages viewed. quiz scores. and survey factors. For each computer lab, a MANOVA using

Wilk's lambda was conducted for feedback type on measures of test quiz scores and pages reviewed between practice and test quizzes. A separate MANOVA was conducted on regulation style by gender for test scores, pages reviewed and attitude factors. An ANOVA was conducted on feedback type by corrective efficiency.

Power Calculation

A power calculation was performed to determine if the tests would have sufficient power to detect a significant difference for the sample size of this study. See Table 2.1 for the analysis. Method for the analysis can be referenced in Cohen (1977).

Research Contributions

The author of the thesis joined this existing research study after the research instruments, instructional material and the crossover research design had been created. The original researchers were interested in differences within students so a repeated-measures design was used. Since the author of this thesis was interested in between-student effects of feedback and review, a cross-sectional approach was used in which students' results were compared against each other within each lab. The author of this thesis contributed the unique literature review, model of corrective efficiency, statistical analysis and write-up.

Table 2.1- Power Analysis of Statistical Tests

(A)Feedback effect(alpha=0.05), to detect an extreme difference[a] of 4 pages reviewed between practice and test quizzes:

variables	effect size index f	power
Lab 2	.2679	.621
Lab 3	.4834	.965
Lab 4	1.5641	1.000

(B)Feedback effect(alpha=0.05), to detect an extreme difference of 10% in test quiz score:

variables	effect size index f	power
Lab 2	.2521	.567
Lab 3	.2597	.513
Lab 4	.2803	.647

(C)Regulation style effect(alpha=0.05), to detect an extreme difference of 4 pages reviewed between practice and test quizzes:

variables	effect size index f	power
Lab 2	.2738	.641
Lab 3	.4865	.968
Lab 4	1.5630	1.000

(D)Regulation style effect(alpha=0.05), to detect an extreme difference of 10% in test quiz score:

variables	effect size index f	power
Lab 2	.2536	.572
Lab 3	.2568	.503
Lab 4	.2667	.603

a) Extreme difference= Mean(maximum)- Mean(minimum).

CHAPTER 3 - RESULTS

Demographics

Of the 254 students who registered in the online anatomy program, 115 consented to participate in the study; 139 did not consent to participate. A breakdown of the number of consenting and non-consenting students who completed each computer lab section is provided in Table 3.1. Due to ethical considerations, student data from non-consenters was not examined. Not all of the students who agreed to participate actually completed all of the labs. In the case of Lab 2, more students completed the test quiz (for marks) than the practice quiz. Lab 3 had the highest attrition rate of the three labs.

Table 3.1 - Number of Students Completing each Lab

Lab 2	Pre-test	Post-test
Total # Students	220	225
Consenters	104	106
Non-Consenters	116	119

Lab 3	Pre-test	Post-test
Total # Students	208	186
Consenters	96	81
Non-Consenters	112	105

Lab 4	Pre-test	Post-test
Total # Students	215	207
Consenters	100	91
Non-Consenters	115	116

The median age of the participants was 20 years old, with a range from 18 to 47 years old. Thirty-four (30%) of the participants were male; 81 (70%) were female. Of the 110 participants who provided their academic year, 44% were in their first year, 32% in their second year, 18% in their third year and 6% were in either fourth or fifth year. Kinesiology majors comprised 57% (65 students) of the sample. Forty – one percent (47 students) of the sample were non-Kinesiology majors. Two percent (3 students) did not give their major.

Pre-Lab Questionnaire

In addition to demographic questions, students were asked a series of questions about how often they used computers and how useful they thought computers were (Appendix C). Of the 115 study participants, only 112 completed this questionnaire. The questions asked about frequency of use and usefulness of email, Internet, and word processing, reasons for taking the course and any reservations or limitations they might have when taking the course. Students were also asked whether the course was of interest to them and whether they felt motivated and confident in taking the course. The final set of questions asked about their previous experience with functional anatomy. Most of the question response choices used a 5-point Likert scale of agreement (4 – Strongly Agree, 3 – Agree, 2 – Neutral, 1 – Disagree, 0 – Strongly Disagree). In a few cases, the response choice was a 5-point Likert scale of use frequency (0 – Never Used, 1 - < Once per Week, 2 – Once per Week, 3 - > Once per Week, 4 - Everyday). Where the survey questions are listed below, the default response is the agreement Likert scale. Questions where the response choices were from the frequency scale will be denoted with an asterisk (*). A factor analysis using principle component analysis and varimax rotation was conducted in order to see how many of the 34 test items were inter-correlated. See Appendix D for the factor analysis table and Scree plot. Eleven factors were extracted from the questionnaire with eigenvalues greater than one. Six factors had an eigenvalue equal to or greater than 1.5 and are detailed below. Items which loaded with a value of 0.5 or higher on a factor were accepted as measuring the same factor.

Based on the nature of the items loading on each factor, the factor names were chosen as follows: Computer Skills, Email to Family and Other Students, Course Motivation, Internet Use, Word Processor Use and Email to Professors. Question items below are numbered to match the question numbers on the questionnaire and the factor analysis tables in the appendix.

Factor 1 – Computers Skills

Six of the question items that loaded onto this factor were:

24. I can make general use of a computer.
25. I can use a computer for word-processing tasks.
26. I can gather information using the World Wide Web.
27. I can use email.
28. I find it easy to learn new software applications.
29. I feel comfortable using computers.

Once the factor analysis was completed, the potential range of scores would be from 0 to 24. The mean value for this factor was 19.5 (SD = 4.5).

Factor 2 – Email to Family and Other Students

The five question items that loaded onto the second factor were:

14. *How frequently do you use the internet to access general or personal information (i.e., hobbies, news)?
18. *How frequently do you use e-mail to communicate with friends or family?
19. How useful do you find e-mail in communicating with friends or family?
20. *How frequently do you use e-mail to communicate with other students?
21. How useful do you find e-mail to communicate with other students?

The possible range of values for this factor would be 0 to 20. The mean score was 13.3 (SD = 5.0).

Factor 3 – Course Motivation

Six items loaded on the third factor.

31. Independent of my overall education/career needs, the topic of this course is of interest to me.
32. The understanding I gain from this course will be beneficial in my future career directions.
33. The labs will provide information that is important for me to know.
35. As I embark on this course I am motivated to do well.
36. I am confident that I will do well in this course.
38. I have previous experience in the area of functional anatomy that may assist my understanding in this course.

The possible range for the course motivation was 0 – 24. The mean value for course motivation was 19.4 (SD = 3.2).

Factor 4 – Internet Use

Three items loaded on the fourth factor.

15. How useful do you find the internet in gaining access to general or personal information?
16. *How frequently do you use the internet to access course related information?
17. How useful do you find the internet in gaining access to course related information?

The possible range of values for this factor would be 0 to 12. The mean score was 8.0 (SD = 2.7).

Factor 5 – Word Processor Use

Four items loaded onto the fifth factor.

12. *How frequently do you use computers to complete word processing tasks (i.e., writing papers, assignments)?
13. How useful do you find computers in helping you complete word processing tasks?
8. *How often do you use a home computer?

9. How useful do you use a home computer?

The possible range of values for this factor would be 0 to 16. The mean score was 12.1 (SD = 2.9).

Factor 6 – Email to Professors

Three items loaded onto the sixth factor.

41d. Please rate whether the recreation has a large demand on your time.
22. *How frequently do you use e-mail to communicate with professors?
23. How useful do you find e-mail to communicate with professors?

The possible range of values for this factor would be 0 to 12. The mean score was 5.4 (SD= 2.6).

A summary of the means and standard deviations for the factors extracted from the pre-lab survey can be seen in Table 3.2.

Table 3.2 - Pre - Lab Questionnaire Factors

Factor	# of items	Max Possible Score	Mean	Std. Deviation	Standardized Score*
Computer Skill	6	24	19.5	4.5	.81
Email to Friends and Students	5	20	13.3	5.0	.67
Course Motivation	6	24	19.4	3.2	.80
Internet Use	3	12	8	2.7	.67
Word Processor Use	4	16	12.1	2.9	.76
Email to Professors	3	12	5.4	2.6	.45

*(Mean/Max Score; out of 1)

Self-Regulation Inventory

All of the 115 participants completed this survey. Seventy-one students were primarily externally regulated. Self and lacking regulation categories both had 22 students. Both the External and Self Regulation scales have a maximum score of 40. The lacking regulation scale had a maximum possible score of 20. The mean participant score for an external regulation strategy was 21 (SD = 6.13), for self-regulation strategy was 16 (SD = 7.35) and for lacking regulation was 8 (SD = 3.71). The mean scores for both the Self-Regulation strategy and Lacking Regulation strategy are the same ratio (16/40 = 8/20), while the mean score for the External Regulation score is slightly higher (21/40).

Post-lab Questionnaire

Of the 115 study participants, only 95 completed the post-lab questionnaire. A factor analysis was conducted on the 33 Likert scale items of the questionnaire. Appendix G contains the items on the questionnaire. The response options for all of the questions on the questionnaire were a 5 point Likert Scale (4 – Strongly Agree, 3 – Agree, 2 – Neutral, 1 – Disagree, 0 – Strongly Disagree). The factor analysis (Appendix G) extracted 9 components from the 33 numerical items of the survey with eigenvalues greater than 1. The five factors with eigenvalues greater than 1.5 are included in the discussion below. Items that loaded with a value of 0.5 or higher on a factor were grouped together.

Factor 1 – Usefulness of Labs

Seven items loaded onto the first factor, which included:

6. The computer links followed logical pathways.
16. The computer component of the course helped me understand material that was covered in the lectures.
17. The media use in the anatomy software program contributed to my understanding of the course material.
18. The labs were strongly related to the course.
19. The content was arranged in a way that made my learning interesting.
27. The computer lab time is a worthwhile component of this course.

The mean value was 16.1 (SD = 6.1), out of a possible range of 0 - 28.

Factor 2 – Computer Skills

Six items loaded onto the second factor.

34. I can make general use of a computer.
35. I can gather information using the World Wide Web.
36. I can use email.
37. I find it easy to learn new software.
38. I feel comfortable using computers.
39. I have concerns about using computers.

Five of the six questions are the same questions that comprise Factor 1 in the pre – lab questionnaire. The question about word processor use was not used in the post-lab questionnaire and but it did include a question that touched upon concerns using computers. The possible range for the computer skills factor was 0 – 24. The mean value for computer skills was 20.4 (SD = 3.9).

Factor 3 – Satisfaction with the Labs

Six items loaded onto the third factor. They included:

20. Using the anatomy software program has improved my understanding of how to navigate material in a web-based environment.
23. I was motivated to do well in the labs throughout the course.
25. The understanding gained from the labs was beneficial to my future career directions.
26. The materials presented in the lab satisfied my reasons for taking this course.
28. If the computer anatomy programme is available to me once this course is over I would access it again.
33. I feel more comfortable with computers now than when I began the course.

The possible range for the Satisfaction factor was 0 – 24. The mean value was 13.3 (SD = 4.4).

Factor 4 – Visual Design of Labs

Four items loaded onto the fourth factor.

7. I sometimes became disoriented within the program.
9. I found the screens to be cluttered and confusing.
10. The visual design was distracting.
12. I found the text difficult to read.

The possible range for the design factor was 0 – 16. The mean value was 7.5 (SD = 3.2). Since the questions in this cluster are worded negatively, a smaller score reflects a positive view, while a larger score reflects a negative view.

Factor 5 – Navigation through the lab

Five items loaded on this factor.

6. The computer links followed logical pathways.
7. I sometimes became disoriented within the program.
8. I was easy to move between content areas (surface anatomy, dissection, glossaries, external sites).
14. The course manual was useful in helping me use the anatomy software program.
15. The instructions for using the anatomy software in the introduction/orientation module made it easy to navigate around the four modules that followed.

The possible range for the navigation factor was 0 – 20. The mean value was 11.9 (SD = 3.2). A summary of the means and standard deviations for the post-lab questionnaire factors can be seen in Table 3.3.

Table 3.3 - Post – Lab Questionnaire Factors

Factor	# of items	Max Possible Score	Mean	Std. Deviation	Standardized Score*
Usefulness of Labs	7	24	16.1	6.1	.67
Computer Skills	6	24	20.4	3.9	.85
Satisfaction with Labs	6	24	13.3	4.4	.55
Design	4	16	7.5	3.2	.47
Navigation	5	20	11.9	3.2	.60

*(Mean/Max Score; out of 1)

Changes Desired for the Software – Written Response

Students were asked what they would change about the software program. Their written responses reflect dissatisfaction with the amount of information provided, the relevancy to course outcomes, and quality of the pictures (Table 3.4). Of the 95 students who completed the questionnaire, 23 declined to comment on this item.

Table 3.4 - Changes Students Want in Anatomy Software Program

Question Response	Frequency	Percentage	Cum. %
Too much information	15	16	16
Too much material that is irrelevant to course objectives / Info not specific enough to be useful	15	16	32
Not enough time to complete	7	7	39
Pictures unclear (couldn't distinguish specific elements from the diagrams)	12	13	52
Pictures too small	3	3	55
Differing orientation of pictures disturbing (parts changed orientation between pictures, loss of context)	2	2	58
Screen confusing/colour choice poor	4	4	62
More quizzes wanted	4	4	66
Organization of content should be changed	3	3	69
Easier quizzes wanted	3	3	72
More frequent access to material wanted	2	2	74
Misc.	2	2	76
Student didn't answer question	23	24	100

Sixty percent of the students' discomfort clustered around the amount of material, the time allotted and the pictures. That breaks down into 16% who felt that there was too much material, 16% who felt that material provided was beyond the scope of the course objectives and 7% who felt that there wasn't enough time. Issues of picture quality include lack of clarity (13%), size (3%) and orientation (2%).

Quiz Test Scores

The number of students who completed the practice quiz and test quiz for each of the three computer lab components differed greatly. Ninety-four students completed both quizzes in Lab 2, seventy-nine completed both quizzes in lab 3 and ninety completed both quizzes in lab 4. Table 3.5 illustrates the quiz score patterns and Table 3.6 shows the mean scores by feedback group. Table 3.7 shows the mean scores by regulation style.

Table 3.5 - Mean Test Scores for Labs 2, 3 and 4

	Lab 2		Lab 3		Lab 4	
	Practice	Test	Practice	Test	Practice	Test
N	104	106	96	81	100	91
Mean	66.3	71.7	66.0	81.0	75.3	73.3
Std. Deviation	18.78	16.04	21.09	15.74	19.90	15.14

Table 3.6 - Mean Test Scores by Feedback Group for Labs 2, 3 and 4

Feedback Group		Lab 2 Test Score	Lab 3 Test Score	Lab 4 Test Score
NF	Mean	72.26	77.41	74.29
	N	31	27	28
	Std. Deviation	18.20	18.73	16.20
KOR	Mean	70.57	82.76	77.94
	N	35	29	34
	Std. Deviation	14.94	16.01	12.25
KCR	Mean	72.50	83.04	66.79
	N	28	23	28
	Std. Deviation	15.31	10.63	15.41
Total	Mean	71.70	81.01	73.33
	N	94	79	90
	Std. Deviation	16.04	15.74	15.14

Table 3.7 - Mean Test Scores by Regulation Style for Labs 2, 3 and 4

Dominant Regulation Style		Lab 2 - Test Quiz Score	Lab 3 - Test Quiz Score	Lab 4 - Test Quiz Score
External	Mean	71.86	80.40	73.68
	Std. Deviation	15.70	16.03	15.99
Self	Mean	74.44	80.67	72.94
	Std. Deviation	17.90	17.51	14.04
Lacks	Mean	68.24	83.57	72.50
	Std. Deviation	15.51	13.36	13.90
Total	Mean	71.70	81.01	73.33
	Std. Deviation	16.04	15.74	15.14

Pages Viewed and Reviewed

The numbers of pages that the students viewed before writing the practice quiz. as well as the number of pages that they reviewed between the practice and test quiz were recorded. Table 3.8 shows the mean number of pages viewed for each lab. Table 3.9 illustrates the pages reviewed by feedback group. Table 3.10 shows the mean pages reviewed by regulation style.

Table 3.8 - Pages Viewed Before Practice Test and Between Practice and Posttests

	Lab 2		Lab 3		Lab 4	
	Pgs Before	Pgs Review	Pgs Before	Pgs Review	Pgs Before	Pgs Review
Mean	20.61	5.29	13.42	3.27	9.68	2.34
Std. Deviation	12.43	6.07	8.12	3.34	3.81	1.04

Table 3.9 - Pages Reviewed (means and sd.) by Feedback Group for Labs 2, 3 and 4

Feedback Group		Lab 2 – Pages Reviewed	Lab 3 – Pages Reviewed	Lab 4 – Pages Reviewed
NF	Mean	6.16	3.37	2.25
	N	31	27	28
	Std. Deviation	7.86	2.24	.75
KOR	Mean	4.60	3.38	2.26
	N	35	29	34
	Std. Deviation	3.62	4.65	.67
KCR	Mean	5.18	3.00	2.54
	N	28	23	28
	Std. Deviation	6.33	2.45	1.55
Total	Mean	5.29	3.27	2.34
	N	94	79	90
	Std. Deviation	6.07	3.34	1.04

Table 3.10 - Pages Viewed (means, s.d.) by Regulation Style for Labs 2, 3 and 4

Dominant Regulation Style		Lab 2 – Pages Reviewed	Lab 3 – Pages Reviewed	Lab 4 – Pages Reviewed
External	Mean	4.63	3.52	2.35
	Std. Deviation	5.27	3.99	1.20
Self	Mean	8.17	3.20	2.53
	Std. Deviation	9.26	2.21	.87
Lacks	Mean	4.53	2.43	2.13
	Std. Deviation	3.24	.85	.34
Total	Mean	5.29	3.27	2.34
	Std. Deviation	6.07	3.34	1.04

Correlations

A Pearson Correlation was conducted using the factors from the three questionnaires, the test scores and the pages viewed. In Lab 2, the amount of review done was negatively correlated to practice quiz score (Table 3.11). A similar, although non-significant direction was evident for Lab 3 and Lab 4.

Table 3.11 - Correlations Between Quiz Scores and Pages Viewed for Labs 2, 3 and 4

	Lab 2	Lab 3	Lab 4
Pearson Correlation	-0.376**	-0.190	-0.128
Sig. (2-tailed)	0.000	0.093	0.230

Being comfortable with sending email to family and friends was negatively correlated to reviewing pages between quizzes as well as test quiz score in Lab 2. Test quiz scores in Lab 2 were also negatively correlated to Internet use (Table 3.12).

No significant relationships were found between regulation style and scores or pages reviewed (Table 3.13).

Table 3.12 - Correlations of Pre-Lab Questionnaire with Test Scores and Pages Viewed

	Confidence with Computers	Email to Family and Other Students	Course Motivation	Internet Use	Word Process at Home	Email to Professor
Lab 2 Review	0.012	-0.215*	0.078	-0.206*	-0.004	0.095
Lab 2 Test Quiz Score	-0.059	-0.208*	0.064	-0.058	-0.060	-0.033
Lab 3 Review	-0.022	-0.027	0.023	-0.035	-0.187	-0.161
Lab 3 Test Quiz Score	-0.057	-0.093	0.086	-0.176	-0.168	-0.007
Lab 4 Review	-0.004	0.024	0.156	0.064	0.078	-0.121
Lab 4 Test Quiz Score	0.007	-0.137	-0.156	-0.168	-0.149	-0.116

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 3.13 - Correlations between Regulation Style and Score/Pages Reviewed

	Regulation External	Self Regulation	Regulation Lacks
Lab 2 Review	-0.062	0.134	-0.139
Lab 2 Test Quiz Score	0.087	0.065	0.050
Lab 3 Review	0.028	0.071	-0.056
Lab 3 Test Quiz Score	0.047	0.001	0.033
Lab 4 Review	-0.010	0.062	-0.148
Lab 4 Test Quiz Score	0.086	0.107	-0.065

The amount of pages reviewed in Lab 3 was negatively correlated to the visual design of the labs. The test quiz score in Lab 3 was related to the perceived usefulness of the labs, satisfaction with the labs and ease of navigation through the labs. In Lab 4, there was an almost significant relationship (p=.053) between test quiz score and satisfaction with the labs (Table 3.14).

Table 3.14 - Correlations of Post-Lab Questionnaire with Test Scores and Pages Viewed

	Usefulness of Labs	Confidence With Computers	Satisfaction with Labs	Visual Design of Labs	Navigation through Labs
Lab 2 Review	-0.052	0.065	-0.019	-0.078	0.118
Lab 2 Test Quiz Score	-0.034	0.062	-0.092	-0.031	0.066
Lab 3 Review	0.210	-0.057	0.082	-0.271*	0.141
Lab 3 Test Quiz Score	0.295**	0.080	0.346**	-0.121	0.251*
Lab 4 Review	0.096	0.003	-0.021	-0.138	-0.080
Lab 4 Test Quiz Score	0.051	-0.007	0.204(p=.053)	-0.011	-0.011

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Hypothesis Testing

The relationships between feedback type and regulation style on measures of test quiz score and pages reviewed were examined. Due to the crossover design, each lab was examined independently. The means and standard deviations are shown in Table 3.15. The relationship between feedback type on pages reviewed and test quiz scores is shown in Table 3.16. The only significant difference found for feedback type on test quiz score was in Lab 4 (Table 3.17). All power calculations used alpha = .05.

Table 3.15 - Means and SD by feedback type for pages reviewed and test quiz score

	Feedback Group	Mean	Std. Deviation
Lab 2 Pages Reviewed	NF	6.161	7.862
	KOR	4.600	3.615
	KCR	5.179	6.331
	Total	5.287	6.065
Lab 2 Test Quiz Score	NF	72.258	18.204
	KOR	70.571	14.940
	KCR	72.500	15.306
	Total	71.702	16.040
Lab 3 Pages Reviewed	NF	3.370	2.239
	KOR	3.379	4.648
	KCR	3.000	2.449
	Total	3.266	3.339
Lab 3 Test Quiz Score	NF	77.407	18.727
	KOR	82.759	16.013
	KCR	83.043	10.632
	Total	81.013	15.738
Lab 4 Pages Reviewed	NF	2.250	0.752
	KOR	2.265	0.666
	KCR	2.536	1.551
	Total	2.344	1.040
Lab 4 Test Quiz Score	NF	74.286	16.200
	KOR	77.941	12.255
	KCR	66.786	15.409
	Total	73.333	15.140

Table 3.16 - Multivariate Tests of Feedback type by Test Score and Review Strategy

	Effect	Value	F	Hypothesis df	Error df	Sig.	Power
Lab 2	Intercept	.047	911.408	2.000	90.000	.000	1.000
	Feedback Type	.986	.318[a]	4.000	180.000	.866	.120
Lab 3	Intercept	.034	1051.666	2.000	75.000	.000	1.000
	Feedback Type	.970	.585[a]	4.000	150.000	.674	.190
Lab 4	Intercept	.030	1382.747	2.000	86.000	.000	1.000
	Feedback Type	.894	2.469	4.000	172.000	.047	.696

a Exact statistic

Table 3.17 - Feedback Type on Pages Reviewed and Test Quiz Score

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Power
Corrected Model	Lab 4 Pages Reviewed	1.490[a]	2	.745	.684	.507	.162
	Lab 4 Test Quiz Score	1947.689[b]	2	973.845	4.592	.013	.764
Intercept	Lab 4 Pages Reviewed	492.942	1	492.942	452.231	.000	1.000
	Lab 4 Test Quiz Score	475668.002	1	475668.002	2242.706	.000	1.000
Feedback Type	Lab 4 Pages Reviewed	1.490	2	.745	.684	.507	.162
	Lab 4 Test Quiz Score	1947.689	2	973.845	4.592	.013	.764
Error	Lab 4 Pages Reviewed	94.832	87	1.090			
	Lab 4 Test Quiz Score	18452.311	87	212.096			
Total	Lab 4 Pages Reviewed	591.000	90				
	Lab 4 Test Quiz Score	504400.000	90				
Corrected Total	Lab 4 Pages Reviewed	96.322	89				
	SCORE41	20400.000	89				

a R Squared = .015 (Adjusted R Squared = -.007)
b R Squared = .095 (Adjusted R Squared = .075)

In Lab 4, there was a significant difference in test quiz score between KOR and KCR feedback types (Table 3.18). Students who received KOR feedback significantly outperformed those who received KCR on the test quiz.

Table 3.18 - Multiple Comparisons Tukey HSD

Dependent Variable	(I) Feedback Group	(J) Feedback Group	Mean Difference (I-J)	Std. Error	Sig.
Lab 4 Test Quiz Score	NF	KOR	-3.66	3.72	.589
		KCR	7.50	3.89	.137
	KOR	NF	3.66	3.72	.589
		KCR	11.16*	3.72	.010
	KCR	NF	-7.50	3.89	.137
		KOR	-11.16*	3.72	.010

Based on observed means.
* The mean difference is significant at the .05 level.

Regulation Style on Review and Achievement

Table 3.19 shows the means and standard deviations for regulation style by pages reviewed and test quiz scores. No significant difference was found for regulation style on test quiz score and pages reviewed (Table 3.20).

Table 3.19 - Regulation Style by Pages Reviewed and Test Quiz Score

	Dominant Regulation Style	Mean	Std. Deviation	N
Lab 2 Pages Reviewed	External	4.78	5.78	45
	Self	8.93	9.98	15
	Lacks	4.67	3.58	12
	Total	5.63	6.73	72
Lab 2 Test Quiz Score	External	76.00	14.37	45
	Self	74.00	18.05	15
	Lacks	65.83	16.76	12
	Total	73.89	15.79	72
Lab 3 Pages Reviewed	External	3.56	4.13	45
	Self	3.20	2.21	15
	Lacks	2.33	.78	12
	Total	3.28	3.44	72
Lab 3 Test Quiz Score	External	81.78	16.14	45
	Self	80.67	17.51	15
	Lacks	85.00	13.82	12
	Total	82.08	15.92	72
Lab 4 Pages Reviewed	External	2.38	1.32	45
	Self	2.47	.92	15
	Lacks	2.17	.39	12
	Total	2.36	1.13	72
Lab 4 Test Quiz Score	External	73.78	15.27	45
	Self	75.33	13.02	15
	Lacks	75.00	14.46	12
	Total	74.31	14.52	72

Table 3.20 - MANOVA Results for Regulation Style on Test Quiz Score and Pages Reviewed

Effect	Value	F	Hypothesis df	Error df	Sig.	Observed Power[b]
Intercept	.021	495.430	6.000	64.000	.000	1.000
Regulation Style	.839	.979[a]	12.000	128.000	.473	.547

a Exact statistic

b Observed power computed using alpha = .05.

Corrective Efficiency by Feedback Type

Table 3.21 shows the means and standard deviations of corrective efficiency for feedback type. The data from Labs 2, 3 and 4 have been collapsed into one table.

Table 3.21 - Means and SD of Corrective Efficiency by Feedback Type

	Feedback Group	N	Mean	Std. Deviation
Lab 2	NF	31	-.001	.032
	KOR	35	.008	.037
	KCR	28	-.005	.049
	Total	94	.001	.039
Lab 3	NF	27	.027	.051
	KOR	29	.013	.040
	KCR	23	.032	.050
	Total	79	.023	.047
Lab 4	NF	28	.010	.121
	KOR	34	.033	.174
	KCR	28	-.041	.063
	Total	90	.003	.133

Three ANOVAs were conducted to determine if there was any difference by feedback type on corrective efficiency. The results of all three labs have been collapsed into Table 3.22. There was no significant difference in corrective efficiency by feedback type.

Table 3.22 - ANOVA Table of Corrective Efficiency by Feedback Type

		Sum of Squares	df	Mean Square	F	Sig.	Power
Lab 2	Between Groups	3.125E-03	2	1.563E-03	.987	.377	.217
	Within Groups	.144	91	1.583E-03			
	Total	.147	93				
Lab 3	Between Groups	.00535	2	.00268	1.184	.312	.252
	Within Groups	.172	76	.00226			
	Total	.177	78				
Lab 4	Between Groups	8.834E-02	2	4.417E-02	2.550	.084	.497
	Within Groups	1.507	87	1.732E-02			
	Total	1.595	89				

CHAPTER 4 - DISCUSSION

Participants

Students' consent to participate was low in this study. Due to the high rate of non-consent (over 50%) of the class, caution should be taken when extrapolating any of these results to the Kinesiology student population. The median age of the participants (20 years old) reflects a group who fit the traditional university demographic of 18 – 24 years of age. Most of the students were in their first year (44%). Three-quarters of the students were in either their first or second years. Roughly half of the students were Kinesiology majors. This demographic profile is not surprising, considering that this course is required for Kinesiology majors and offered at the 200 level. Students were required to complete the online labs as part of their course; use of their test scores for the study was voluntary.

Questionnaire Factors

One of the purposes of the pre- and post-lab questionnaires was to measure some of the factors that might inhibit students' use of feedback. Since both computer anxiety and lack of motivation could potentially inhibit the students' use of computer-mediated feedback, items were included on the questionnaires that would measure computer use and motivation. Regulation style was also identified in the literature review as a potential block to full use of feedback information, especially for externally regulated students.

Prior to completing the course, the students had a very positive attitude towards using computer applications and towards the course in general. They had a positive attitude towards using word processors, sending email to their friends, family and other students as well as using the Internet. Their attitude towards sending email to professors was neutral.

The mean score for external regulation was higher than the mean scores for either self or lacking regulation styles. The students appear to be slightly more inclined to an external regulation strategy than either a self-regulation strategy or lacking any strategy. An external strategy indicates that students rely on factors outside of themselves to ascertain what material needs to be learned as well as whether they understand it or not. Since the regulation survey was designed to identify and categorize participants into one of three styles exclusively, it is puzzling why a correlation between External and Self regulation styles ($r = .570$, $p<.01$) as well as a correlation between External and Lacking Regulation factors ($r = .366$, $p<.01$) was observed. It may be that regulation style is better measured on a continuous scale, with lacking regulation on one end and self-regulation on the other end rather than three distinct categorical styles.

On the post-lab questionnaire, the mean value for usefulness of the labs was positive. The students felt that the online labs helped them understand the lecture material, were interesting and related to the course materials. Students continued to have a very positive opinion of their computer skills and abilities. There was very slight increase in positive response to this cluster from pre-lab to post-lab.

Satisfaction with the labs was neutral. Questions in the satisfaction cluster asked about relevance, confidence and satisfaction, 3 of the 4 elements in Keller's (1988) model of motivation. The motivation in course cluster of the pre-lab questionnaire included some of the same questions as the satisfaction with labs factor on the post lab survey. In fact 2 of the 6 questions were the same on both surveys. Although the remaining 4 question items were not identical in this cluster between the pre/post surveys, they appear to measure the same general construct of motivation. Between the pre and post lab surveys, student motivation dropped from .80 to .55. Students also felt neutral about the visual design of the labs. The design factor covered questions about becoming lost and disoriented, the screens being cluttered, confusing or distracting and the text being difficult to read.

Student Written Responses

Students were asked if they could change one thing about the program, what it would be. Twenty four percent of the class did not answer this question. Thirty two percent of the class, which translates to 48% of the respondents, felt that there was too much material for the time allotted and that it was not related to course objectives. An additional 23% of the respondents felt that the quality of the pictures was poor. Combined, the amount and scope of material along with picture quality comprises 71% of the dissatisfaction expressed with the course. In this situation, students appear to be frustrated by the quantity of material, resulting in an overall learning experience that is too challenging for the time allotted. These findings may related to the neutral views the participants held towards the visual design of the labs and their neutral view of the usefulness of the labs.

Quiz Test Scores

More students participated in the quizzes in lab 2 than in the other two labs. Mean test score was higher than mean practice score. Being comfortable with sending email to family and friends had a negative effect on Lab 2 test score.

Lab 3 had the highest attrition rate of the three labs. Similar to lab 2, students' mean test score was higher than their mean practice score. By this point, roughly halfway through the semester, perceived usefulness and satisfaction with the labs as well as ease of navigation all positively correlated to test score. Those students who were focused on their goals and could navigate with ease, performed better on the test.

By lab 4, the relationship of practice and test score had reversed - the mean test score was slightly lower than the practice score. Satisfaction with the labs was the only factor that approached a significant correlation in the last lab. Only in lab 4. were significant differences found for feedback type. Students who received KOR feedback performed significantly better than students who received KCR feedback. This was not the expected direction of effect predicted, based on the literature reviewed. Previous research would seem to indicate that KCR feedback should be more effective than KOR type feedback. It is possible that due to the simple nature of the task (Label the structure), that simple feedback (KOR) was sufficient. No significant differences were found for feedback type in Labs 2 or 3.

After visually inspecting the means, no obvious difference in test scores by regulation style was found for any of the labs. This was confirmed when no statistically significant difference was found. The sample of students in this study is non-homogeneous – with the standard deviations of the mean practice and test scores are very high. This may have contributed to a lack of significance on most of the measures for most of the labs.

Pages Reviewed

Over the duration of the semester, students read fewer pages of content before taking each practice exam and reviewed fewer pages between practice and test quizzes. The mean pages decreased as the students moved from Lab 2 to Lab 3 and 4. The standard deviations are also quite high.

In lab 2, the No Feedback group reviewed the most pages, followed by the KCR group and the KOR group. Students who had a self-regulation style reviewed more pages than either the external or lacking regulation styles. However, the mean differences by feedback type and regulation style were statistically insignificant. In Lab 2 being comfortable with using the Internet and sending email to family and friends had a significant, negative effect on pages reviewed. The effect of email is the same for both test scores and pages reviewed.

Differences in pages reviewed in lab 3 and 4 were very small – less than one page difference between the three feedback groups. In lab 3, the visual design was significantly related to the amount of pages reviewed. This seems to indicate that students who became disoriented and distracted reviewed fewer pages. Little difference was observed on regulation styles for pages reviewed in Lab 3 and 4. The mean differences between for pages reviewed by feedback group and regulation style observed were statistically insignificant.

Three Snapshots in Time

Issues that relate to student performance appear to change at different points in the semester. Students who were comfortable using technology for social purposes before the lab began had reduced lab performance. While using computers regularly does seem to reduce anxiety and the problems with using computer based learning, non-educational uses may compete with course requirements for students' time. Having a positive view of email and Internet (both in attitude and frequency of use) before the labs began related to decreased achievement measures in lab 2.

By the middle of the course, students were more focused on their course goals. Those who reported that the course was useful, satisfying and easy to navigate at the end of the course had higher test quiz scores and reviewed more pages in lab 3. It's interesting to note that the negative open-ended comments about the design which they gave at the end of the labs, supports the findings that review was related to visual design in lab 3.

It's not particularly surprising that motivation is associated with test scores or that navigation is linked to review. What is puzzling is that motivation and navigation were not related to achievement measures for Labs 2 and 4. Post-lab attitude seemed to have little impact on student scores or behaviour in lab 4. Post – lab satisfaction remained a weak indicator of test quiz score in lab 4, although its impact was less than in Lab 3.

Practice Quiz Predicting Review Strategy

Only in Lab 2 was a relationship observed between the score on the practice quiz and the number of pages the student reviewed. The negative correlation shows that the higher the marks on the quiz score, the fewer pages the students chose to review. This relationship supports one of the study hypotheses, namely that there would be a relationship between test score and review strategy. A similar, but non-significant relationship is seen for Lab 3 ($r = -0.190$, $p=0.093$). Whether Lab 4 also shows the same non-significant trend is debatable ($r = -0.128$, $p=0.230$).

Corrective Efficiency

None of the feedback types seemed more efficient at correcting student errors for the least time invested. The standard deviation of the means is very large; for two of the labs it is 10 times larger than the mean value.

Effectiveness of Feedback

Prior to starting the course, the students were confident their ability to complete the course and use a variety of computer applications. It would appear that the learners were ready, willing and able to make optimal use of the instructional materials. Based on previous studies of feedback, one would expect to see some difference in test performance based on type of feedback received across all three labs. In this particular study, feedback only affected test scores in one of the three labs.

In addition, it is clear that students did not review much, if any material between the practice and the posttest. As the students progressed further into the semester, the number of pages that they read before each practice exam as well as the number of pages they reviewed between the practice and test quizzes decreased. Based on their written comments at the end of the semester, it's not completely clear whether they were frustrated with the scope of content in the dissection or functional anatomy portions of the labs. Since there was much less content in the functional anatomy section, one can speculate that their comments about the scope of the content relates to the dissection portion. Their dissatisfaction with the pictures was aimed at the dissection portion.

The results of this study seem to indicate that students were reluctant to utilise the material to the fullest extent. It is unclear whether students were struggling with the volume of material or if they were merely unable to identify the required elements of the commercial software package and becoming lost. Perhaps with additional navigational supports for the dissection portion, students would be better able to use the material. Making the essential aspects of the material more transparent to students might increase the motivation of the students, by clearly indicating the relevance of the material to their needs. This would also aid the externally regulated students, who rely on the material to provide them with guidance.

Limitations

As outlined above, the amount of content and/or the navigational structures in the dissection portion of the lab limited the ability of the students to attend to the feedback provided. It is very difficult to determine if feedback had no effect, as this study seems to show, or if the students were just unable to utilise the feedback.

The power calculation for the statistical tests seem to indicate that for some of the variables under examination, the number of subjects may not have been sufficient to determine an effect. Finally, more than half of the students in the Kinesiology class did not consent to participate in the study. Even if this study had found an effect for feedback, gender or regulation style, generalizing to the broader Kinesiology population would be problematic.

Conclusion and suggestions for the future

Although this study was designed to look at the effects of feedback and regulation style on posttest achievement and review strategy, due to intervening variables, no effect was found for any of the study variables. While this is unfortunate for furthering knowledge about the effects of feedback, this study has shed some light on the barriers students face in courses with large bodies of information that must be mastered. When students perceive that material is not relevant to their goals or the course, their participation decreases. In order to assess the effects of feedback, students must remain motivated and engaged with the course materials.

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APPENDICES

APPENDIX A

The University of Calgary-Consent Form
Research Title: Alternative Feedback Mechanisms in Web-Based Anatomy Labs
Investigators: Dr. Murray Maitland and Dr. Larry Katz

This consent form, a copy of which has been provided for you, is only part of the process of informed consent. It should give you a basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully.

Withholding consent does not relinquish your responsibility to participate in the activities of KNES 261. These activities include:
Using the anatomy information presented on-line in a net-based computer lab.
Completing on-line quizzes relating to your understanding of the anatomy information.
Receiving on-line feedback relating to your performance on certain quizzes.

As a participant in the research study you will be requested to complete activities beyond the scope, and in addition to the regular course requirements of KNES 261. You will be asked to:
Provide background information on entrance and exit questionnaires.
Agree to the use of questionnaire information in statistical analyses and written reports.
Permit data related to quiz performance to be collected, analyzed, and used in written reports.

Your right to anonymity will be maintained by:
Using participant identification numbers rather than student numbers.
Using password protected computer systems.
Only the study investigators and research assistants will have access to information collected.
Data from the research study will be analyzed after course marks have been finalized.
Individuals will not be identified in reports or papers.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate. Please not that you are free to withdraw from the study without effecting your position in KNES 261 and the University as a whole. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact:

Dr. Murray Maitland 220-8943
Dr. Larry Katz 220-3418

If you have any questions concerning your rights as a possible participant in this research, please contact The Conjoint Faculty of Ethics Committee, University of Calgary at 220-3381.

I, ______________________________ have understood to my satisfaction the information
(Name of Participant, PRINTED)
regarding my participation in the research project entitled Alternative Feedback Mechanisms in Web-Based Anatomy Labs and agree to participate.

______________________ ______________________
(Signature of Participant) (Date)

______________________ ______________________
(Signature of Witness) (Date)

APPENDIX B

Functional Anatomy Program

During Lab 1, students were asked to find the anatomical snuffbox in the dissection program.

The following page (Figure 1) was visible after students launched the program.

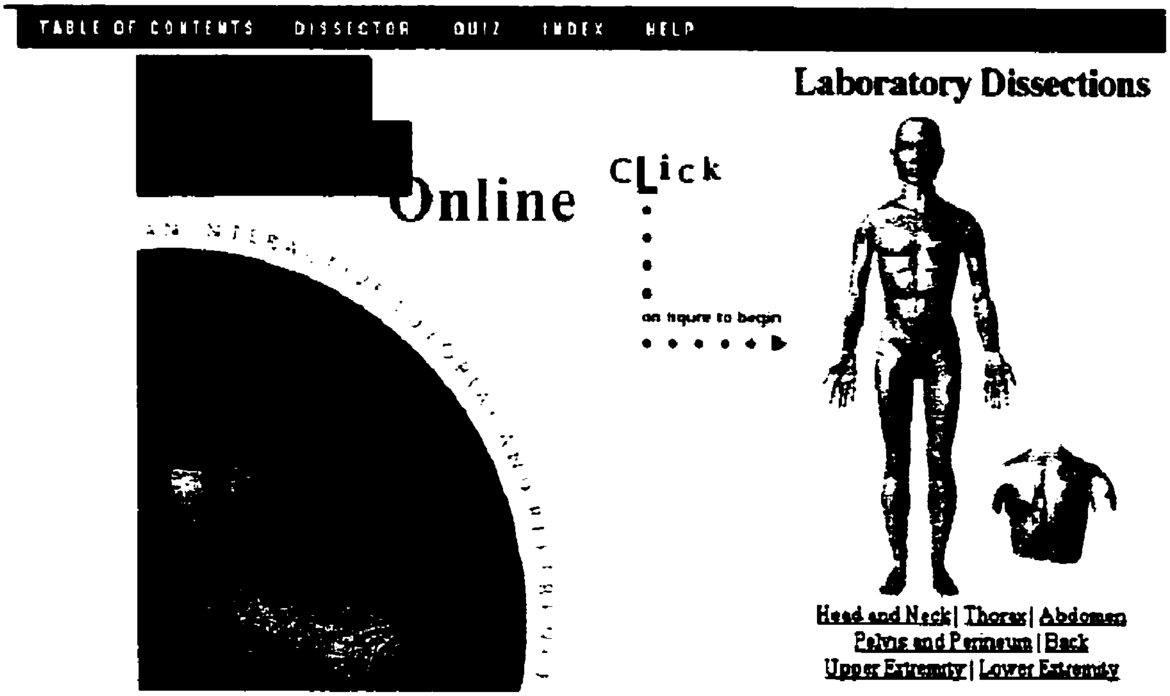


Figure1

From this page, the students could click on the Index, and select the Anatomical Snuffbox entry and then the portion of Laboratory 9 that contained information on the Snuffbox (Figure 2)

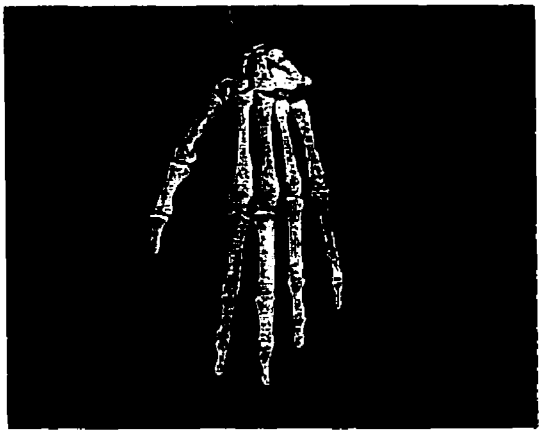
TABLE OF CONTENTS DISSECTOR QUIZ INDEX HELP

Upper Extremity

● Previous Page ● Next Page ● Outline

Laboratory 9. Extensor Region of Forearm and Dorsum of Hand

Osteology



Click image to view full screen

For a review of the bones of the wrist and hand see Figure 8.1 ; Figure 9.1. Observe on the dorsum of your hand, the long tend of the extensor muscles of the forearm as they pass over the dor surface of the metacarpophalangeal (m/p) joints.

Links and References:
Grant's: 6.101, 6.102, 6.118, and 6.130
Netter (1ed.): 424-431 (2ed.): 420-427
Rohen/Yokochi: 353-355

Figure2

Students had the opportunity to explore the structure of the snuffbox as well as the surrounding bones, muscles and other tissues of the hand (Figure 3).

TABLE OF CONTENTS DISSECTOR QUIZ INDEX HELP

Upper Extremity

● Previous Page ● Next Page ● Outline

Laboratory 9. Extensor Region of Forearm and Dorsum of Hand

Step 2. Anatomical "Snuff Box"

Click image to view full screen

● Previous Image ● Next Image

The boundaries and contents of the "**anatomical snuff box**" will be studied. Identify and clean the tendons of **abductor pollicis longus muscle** [probe] and **extensor pollicis brevis muscle** [probe]. These tendons border the "anatomical snuff box" laterally, and the tendon of **extensor pollicis longus muscle** borders it medially (Figure 9.2).

Identify the **RADIAL ARTERY**, which passes deep to the tendons that border the "anatomical snuff box," and follow it distally to where it disappears between the two heads of the **first dorsal interosseous muscle** [distal portion of the RADIAL ARTERY is indicated by the probe]. Identify the **superficial branch radial nerve**.

Figure3

Content – Labs 2, 3 and 4

Each lab covered a portion of the human body. Lab 2 covered the upper extremity, lab 3 covered the lower extremity and lab 4 covered the torso. Each lab consisted of five components: Introduction, Surface Anatomy, Dissection, Movement and Testing. The introduction section covered the rationale for studying the structure, activities where the structure would be used and common injuries. Broad outcomes of what the student would be able to do with the information were also included. See Figure 4 to see page one of the introduction to Lab 2.

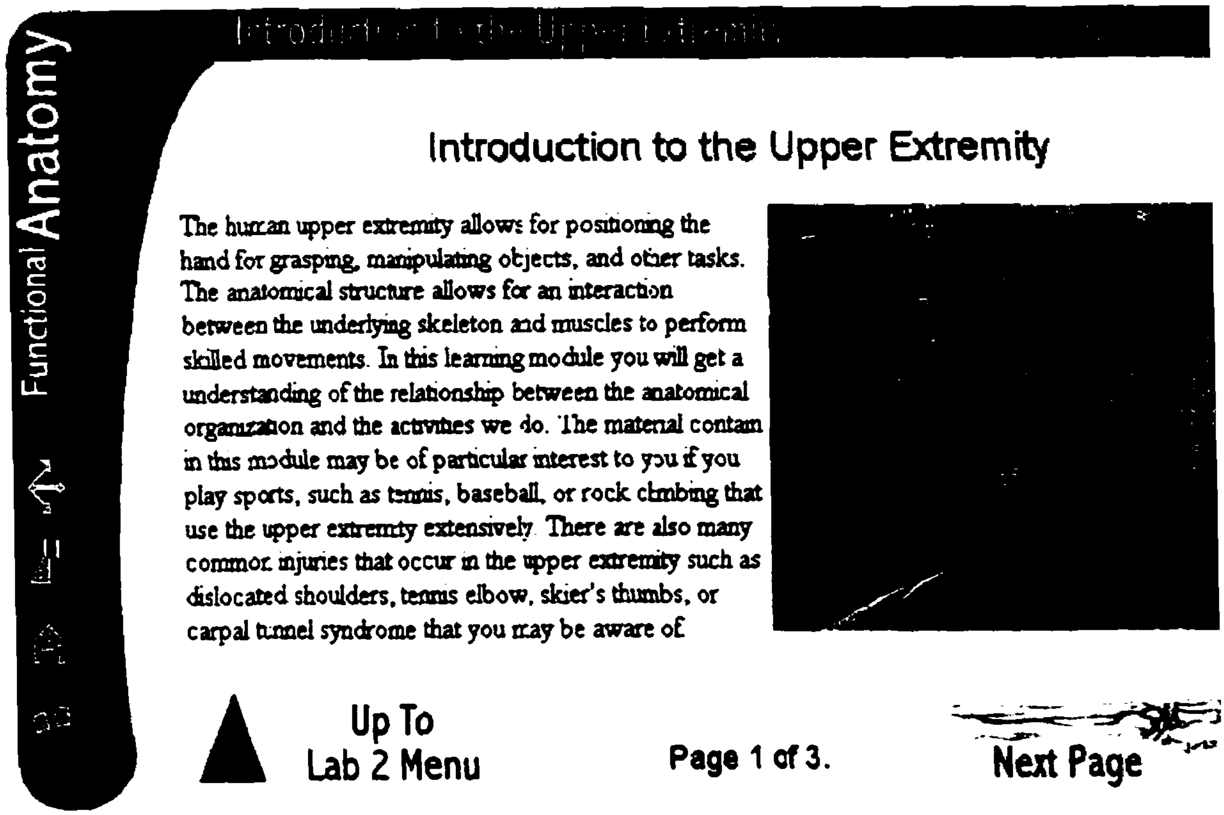


Figure 4

In the surface anatomy section, the students were shown the surface muscle and bone structures. See Figure 5 for the surface view. When the student clicked on "Muscle" or "Bones", they would see those structures. The view could be rotated for a posterior or anterior perspective.

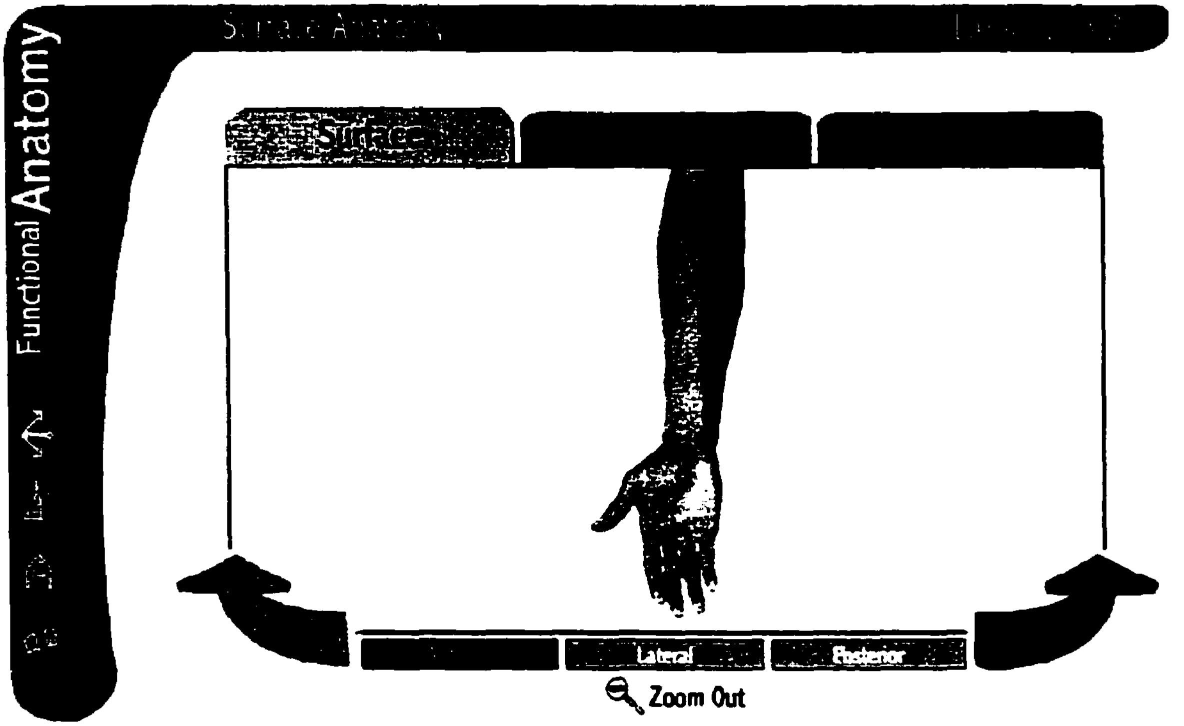


Figure 5

After viewing the Functional Anatomy, students could view the different layers of the relevant body part. The dissection started at the skin layer and moved down to the bone layer. The structure pointed to by the probe was described. After viewing the dissection, the student selected a joint to view its movement. See Figure 6 for the index of joints for Lab 2 – Upper Extremity.

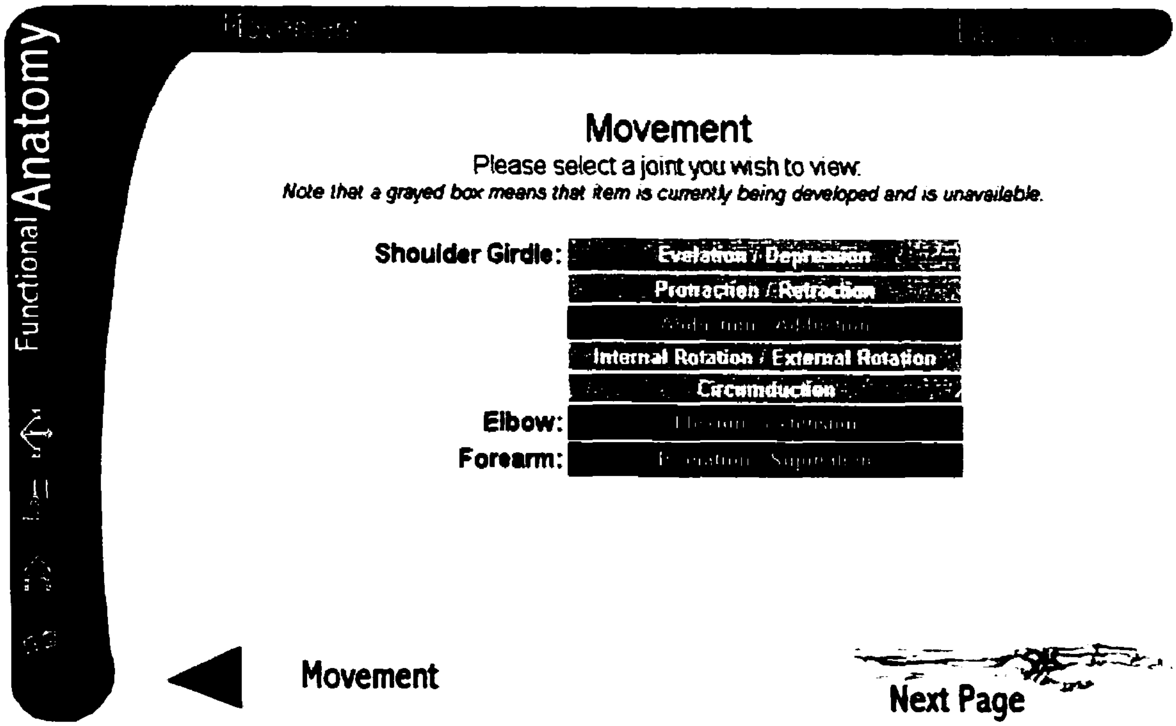


Figure 6

After selecting a joint from the index, the student could view the motion of the skeletal structure only as well as the entire structure in two video windows. See Figure 7 for an example from Lab 2 of forearm rotation.

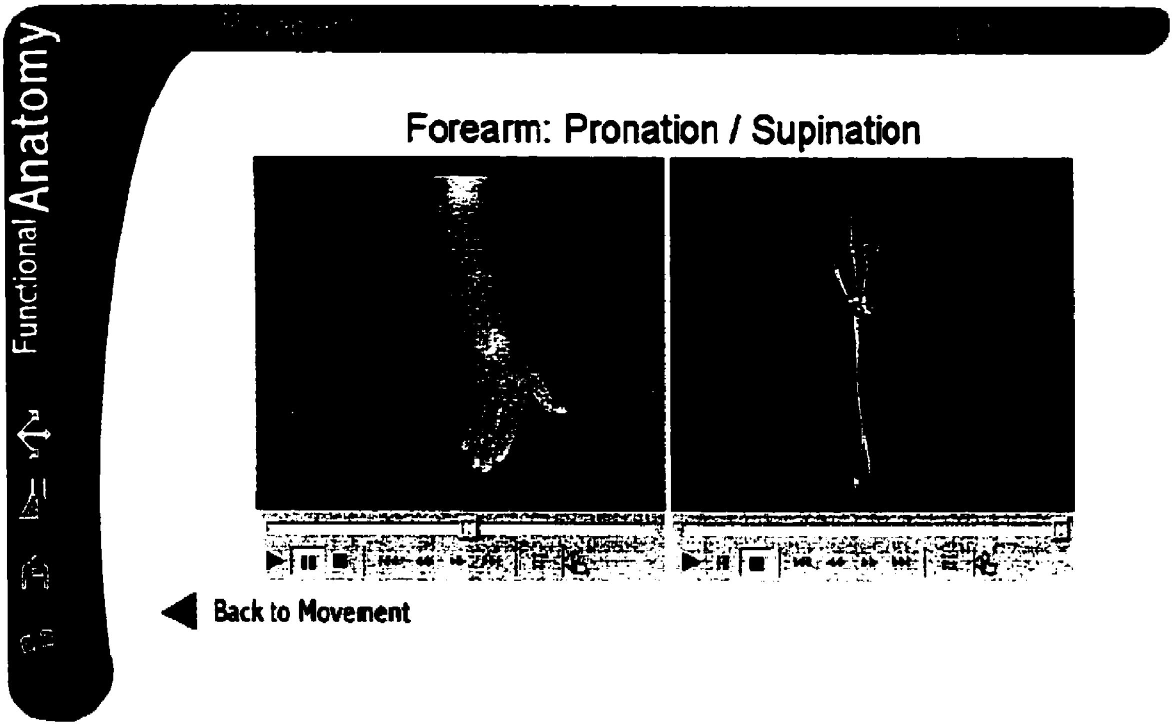


Figure4

Finally, after completing the surface anatomy, dissection and movement portions of the lab, students would proceed to the practice-testing portion of the lab. Once students had begun the lab, they were not allowed to re-take it. Students were advised to ensure that they did not close the browser until they were finished the lab, since they would not be able to re-start the practice quiz. Test questions assessed the students' ability to identify structures based on dissection slides. Students could expand the picture to full screen. A small human figure in the lower left corner of the screen indicated the orientation of the structure. See Figure 8 for an example test question from Lab 2.

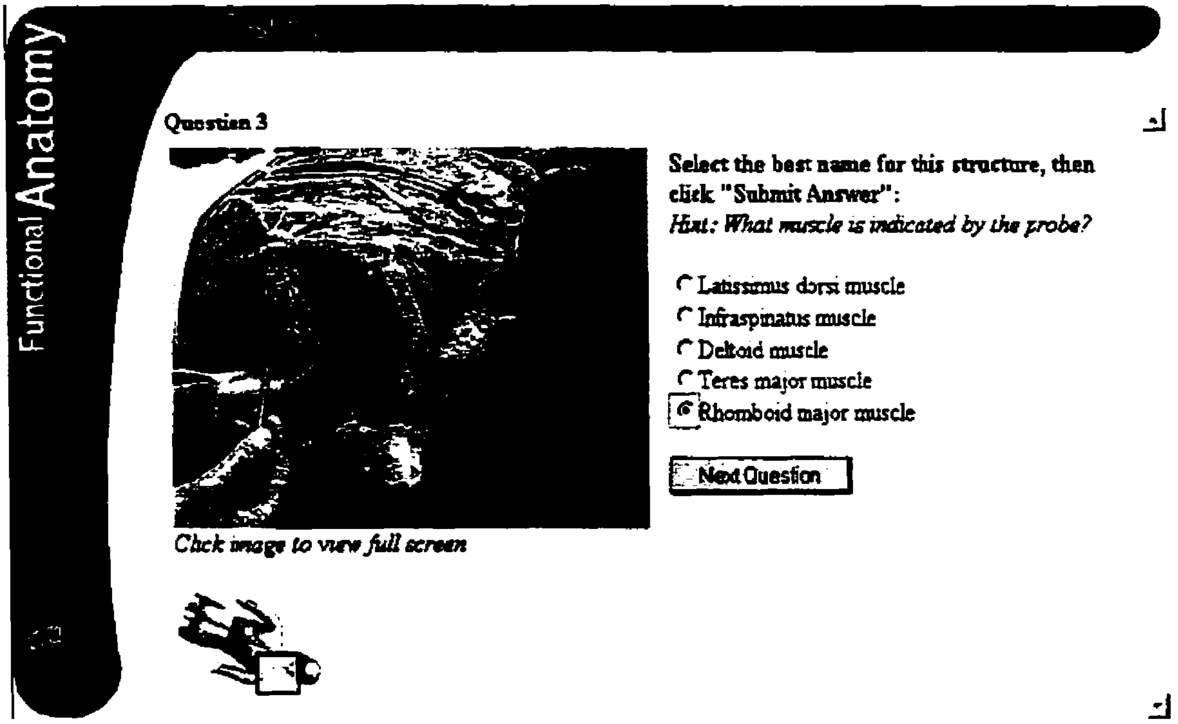


Figure5

Students in the no feedback group received no additional information. Those in the KOR group were told if their answer was correct or not after they selected the next question button. Students in the KCR group received one sentence per answer item about why it was correct or incorrect.

APPENDIX C
Pre - Course Questionnaire

Date of Birth
YYYY/MM/DD

Gender
O Male O Female

Academic Major: ______________

Academic Year (1-4): ______________

1. How many academic credits are you taking this semester? _____

2. How many academic credits have you earned to date? ______

3. Which operating system do you have internet access with:
O Windows O Macintosh O other

4. Where do you have internet access?
O home O school O work

5. Do you use computer facilities on campus?
O yes O no

6. If you do NOT use computer facilities on campus, why not? ________________

7. How many hours per week (in class, independent study, and completion of assignments) do you expect to spend working towards completion of this class?

____

8. How often do you use a home computer?
O never used O <once per week O once per week
O >once per week O everyday

9. How useful do you find home computers?
O not applicable O not useful O useful
O quite useful O very useful

10. How often do you use the computer facilities on campus?
O never used O <once per week O once per week
O >once per week O everyday

11. How useful do you find the computer facilities on campus?
O not applicable O not useful O useful
O quite useful O very useful

12. How frequently do you use computers to complete word processing tasks (i.e., writing papers, assignments)?
- never used
- <once per week
- once per week
- >once per week
- everyday

13. How useful do you find computers in helping you complete word processing tasks?
- not applicable
- not useful
- useful
- quite useful
- very useful

14. How frequently do you use the internet to access general or personal information (i.e., hobbies, news)?
- never used
- <once per week
- once per week
- >once per week
- everyday

15. How useful do you find the internet in gaining access to general or personal information?
- not applicable
- not useful
- useful
- quite useful
- very useful

16. How frequently do you use the internet to access course related information?
- never used
- <once per week
- once per week
- >once per week
- everyday

17. How useful do you find the internet in gaining access to course related information?
- not applicable
- not useful
- useful
- quite useful
- very useful

18. How frequently do you use e-mail to communicate with friends or family?
- never used
- <once per week
- once per week
- >once per week
- everyday

19. How useful do you find e-mail in communicating with friends or family?
- not applicable
- not useful
- useful
- quite useful
- very useful

20. How frequently do you use e-mail to communicate with other students?
- never used
- <once per week
- once per week
- >once per week
- everyday

21. How useful do you find e-mail to communicate with other students?
- not applicable
- not useful
- useful
- quite useful
- very useful

22. How frequently do you use e-mail to communicate with professors?
- never used
- <once per week
- once per week
- >once per week
- everyday

23. How useful do you find e-mail to communicate with professors?
- ❍ not applicable
- ❍ not useful
- ❍ useful
- ❍ quite useful
- ❍ very useful

24. I can make general use of a computer.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

25. I can use a computer for word-processing tasks.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

26. I can gather information using the World Wide Web.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

27. I can use e-mail.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

28. I find it easy to learn new software applications.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

29. I feel comfortable using computers.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

30. Please indicate your reason for taking this course from the list provided.
You can select more than 1 reason.
- ❍ required course
- ❍ course is part of my career path
- ❍ pursuit of general knowledge
- ❍ course is of secondary interest to me

31. Independent of my overall education/career needs, the topic of this course is of interest to me.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

32. The understanding I gain from this course will be beneficial in my future career directions.
- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

33. The labs will provide information that is important for me to know.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

34. I feel that there will be aspects of KNES 261 that will be difficult for me.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

35. As I embark on this course I am motivated to do well.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

36. I am confident that I will do well in this course.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

37. I have reservations about working with cadavers.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

38. I have previous experience in the area of functional anatomy that may assist my understanding in this course.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

39. I have taken an anatomy course before.
- ❍ yes ❍ no

40. I think the demands placed on my time may make it difficult for me to fully complete the labs.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

41. Please rate whether the following have a large demand on your time.

a) Job
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

b) Family
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

c) Other courses
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

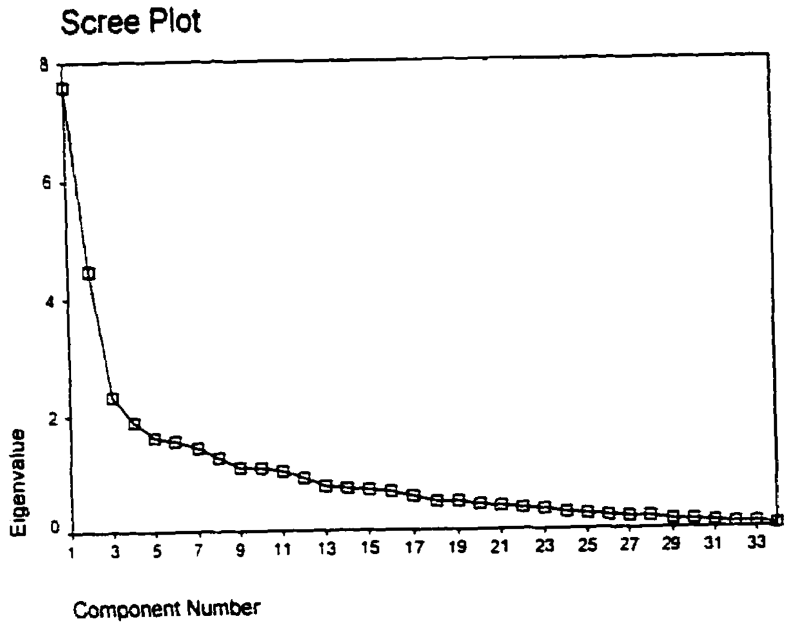
d) Recreation
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

APPENDIX D
Factor Analysis – Pre Course Survey

Rotated Component Matrix	1	2	3	4	5	6	7	8	9	10	11
8. FreqHmComp	0.274	0.276	0.069	0.266	0.533	-0.072	-0.314	0.036	-0.156	-0.147	-0.051
9. UseHoComp	0.239	0.260	0.206	0.139	0.644	0.204	0.129	0.061	-0.274	-0.049	-0.008
10. FreqCComp	0.026	0.164	-0.111	0.116	0.078	-0.120	0.860	0.008	-0.017	0.001	-0.015
11. UseCComp	0.002	0.189	0.047	0.155	0.093	0.038	0.853	-0.061	0.002	0.051	-0.027
12. FreqWordPro	0.054	0.083	-0.173	-0.094	0.560	0.344	0.109	0.226	0.156	0.220	-0.196
13. UseWord Pro	0.217	0.130	0.025	0.229	0.714	0.053	0.206	-0.114	-0.034	0.069	0.102
14. FreqI-netPers	0.179	0.534	-0.024	0.305	0.248	0.014	0.085	0.302	-0.336	-0.214	0.067
15. UseI-netPers	0.229	0.327	0.039	0.534	0.139	0.145	0.222	0.135	-0.227	0.130	0.050
16. FreqI-netCour	0.038	0.140	0.022	0.793	0.109	0.225	0.090	0.043	0.190	0.057	-0.093
17. UseI-netCour	0.039	0.262	0.101	0.780	0.135	0.143	0.142	-0.124	-0.072	0.061	-0.077
18. FreqEmailFa	0.179	0.741	-0.019	0.363	0.207	-0.074	0.091	0.111	-0.068	-0.226	0.066
19. UseEmailFam	0.111	0.738	0.058	0.393	0.137	-0.061	0.064	-0.120	-0.043	-0.029	0.026
20. FreqEmailStu	0.128	0.843	-0.030	0.001	0.063	0.239	0.163	0.039	0.100	0.090	-0.115
21. UseEmailStud	0.214	0.816	-0.030	0.044	0.057	0.307	0.167	-0.036	0.123	0.200	-0.060
22. FreqEmailPro	0.071	0.260	-0.136	0.257	0.103	0.722	-0.071	0.068	-0.058	-0.081	0.018
23. UseEmailProf	0.108	0.191	0.034	0.309	0.039	0.731	-0.036	-0.237	-0.047	0.066	0.147
24. CanUseComp	0.819	0.088	0.125	0.047	0.083	-0.092	-0.113	-0.051	-0.023	0.132	-0.130
25. UseWordProc	0.803	0.078	0.083	-0.063	0.163	-0.154	-0.207	0.047	0.106	0.047	-0.060
26. UseWWW	0.846	0.160	0.090	0.055	0.037	-0.051	-0.055	0.195	0.036	0.063	0.090
27. Use Email	0.789	0.225	0.195	-0.033	0.123	-0.157	-0.021	0.110	0.027	0.017	0.155
28. LearnSoftwre	0.761	0.028	0.189	0.051	0.005	0.268	0.222	-0.079	-0.006	-0.059	-0.046
29. ComfortComp	0.805	0.110	0.133	0.143	0.116	0.153	0.198	-0.036	0.050	0.041	0.054
31. TopicInterest	0.051	0.025	0.749	-0.167	0.152	-0.001	-0.046	-0.210	0.109	0.090	-0.064
32. BenefitCareer	0.034	0.011	0.791	0.117	0.031	-0.111	-0.023	-0.030	0.083	0.037	0.191
33. LabsInfo	0.190	0.061	0.756	0.040	0.008	0.048	-0.121	0.241	-0.132	0.139	0.095
34. KnesDifficult	0.135	0.002	0.068	0.179	0.374	-0.134	-0.043	0.267	0.298	0.468	0.246
35. Motivated	0.304	-0.097	0.755	0.130	-0.017	-0.125	0.040	0.081	0.036	0.205	0.005
36. Confident	0.350	-0.081	0.622	0.033	-0.167	0.099	0.096	0.115	-0.033	-0.112	-0.267
37. ReserCadavs	0.020	-0.047	0.049	-0.098	-0.002	0.062	-0.020	0.000	0.057	0.014	0.895
38. PrevAnat Exp	0.158	0.151	0.417	0.068	0.116	-0.080	0.054	-0.156	0.487	-0.229	-0.249
40.											
41. JobTime	0.106	-0.004	0.023	-0.002	-0.136	0.007	-0.010	0.218	0.775	-0.037	0.125
42. FamilyTime	0.107	0.044	0.063	-0.023	0.036	0.014	-0.051	0.855	0.142	0.050	-0.004
43. OtherCoursTi	0.133	0.003	0.309	0.091	0.048	-0.079	0.083	0.029	-0.154	0.763	-0.034
44. RecTime	0.180	0.102	0.053	0.047	-0.151	-0.558	0.017	-0.251	-0.054	0.381	0.068

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 19 iterations.



Pre Course Survey – Factor Analysis

APPENDIX E

Self-Regulation survey

1. If a textbook contains questions or assignments, I complete them as soon as I come across them while studying.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

2. I study all learning units in the same way.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

3. I realize that it is not clear to me what information I have to remember.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

4. I find the introduction, learning objectives, instructions, assignments and tests are indispensable tools for my studies.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

5. I check my learning progress exclusively by completing the questions, exercises and tests provided by the teacher or the textbook.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

6. I notice that I have trouble processing a large amount of subject matter.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

7. Besides the course material, I also study other literature related to the content of the course.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

8. I learn everything exactly as it is written in the course materials.

a) I never do this | b) I sometimes do this | c) I do this regularly | d) I often do this | e) I almost always do this

9. I notice that it is difficult for me to determine whether I have mastered the subject matter sufficiently.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

10. To check my learning progress, I try to formulate the main points in my own words after I have studied it.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

11. When I begin a new learning unit, I first think about the way in which I can best study the material.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

12. I realize that the objectives of the course are too general for me to offer any support.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

13. I do more than I am expected to do in a course.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

14. If I am able to give a good answer to the questions posed in the textbook or by the teacher, I decide that I have a good command of the subject matter.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

15. When I have problems with a part of the subject matter, I try to analyse why it is difficult for me.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

16. I study according to the instructions given in the course materials.

a) I never do this b) I sometimes do this c) I do this regularly d) I often do this e) I almost always do this

17. To test my learning progress, I try to answer questions about the subject matter which I make up myself.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

18. I often need someone to fall back on in case of difficulties.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

19. I use other sources to add to the information provided in the study materials.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

20. When completing self-study assignments, I make sure I practice all the material that is described in a course.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

21. To test whether I have mastered the subject matter, I try to think up other examples and problems besides the ones given in the study materials or by the teacher.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

22. I use the instructions and the course objectives given by the teacher to know exactly what to do.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

23. When I am studying, I also direct myself toward learning objectives that are not in the course, but that I set myself.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

24. When I don't understand part of a text very well, I try to find other literature that has to do with the course content.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

25. If I am able to complete all the assignments given in the study materials or by the teacher, I decide that I have a good understanding of the subject matter.

a) I never do this	b) I sometimes do this	c) I do this regularly	d) I often do this	e) I almost always do this

APPENDIX F
Post – Course Questionnaire

1. I had enough time in labs.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

2. There were enough open lab times to meet my needs.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

3. I would like access to the computer lab from home.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

4. Having access to the anatomy software from home is beneficial to me.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

5. I feel that I benefited from having the anatomy software available to me outside computer lab times.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

6. The computer links followed logical pathways.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

7. I sometimes became disoriented within the program.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

8. It was easy to move between content areas (surface anatomy, dissection, glossaries, external sites).
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

9. I found the screens to be cluttered and confusing.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

10. The visual design was distracting.
○ strongly agree ○ agree ○ neutral
○ disagree ○ strongly disagree

11. If yes, why was it distracting?

____

12. I found the text difficult to read.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

13. The introductory/orientation module made me confident in working through the modules that followed.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

14. The course manual was useful in helping me use the anatomy software programme.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

15. The instructions for using the anatomy software in the introductory/orientation module made it easy to navigate around the four modules that followed.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

16. The computer component of the course helped me understand material that was covered in the lectures.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

17. The media use in the anatomy software program contributed to my understanding of the course material.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

18. The labs were strongly related to the course.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

19. The content was arranged in a way that made my learning interesting.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

20. Using the anatomy software program has improved my understanding of how to navigate material in a web-based environment.
- ❍ strongly agree ❍ agree ❍ neutral
- ❍ disagree ❍ strongly disagree

21. Having so much material (surface anatomy, dissection software, tests, etc) in the anatomy software made it hard for me to know if I had covered all the required material.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

22. The on-line testing at the end of each module gave me a clear idea of whether I had learned the material I needed from each module.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

23. I was motivated to do well in the labs throughout the course.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

24. I would have made better use of the labs if…

- ❍ I thought they would improve my understanding.
- ❍ They were easier to understand.
- ❍ The program was easier to use.
- ❍ I had more time.
- ❍ Other

25. The understanding gained from the labs was beneficial to my future career directions.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

26. The materials presented in the lab satisfied my reasons for taking this course.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

27. The computer lab time is a worthwhile component of this course.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

28. If the computer anatomy programme is available to me once this course is over I would access it again.

- ❍ strongly agree
- ❍ agree
- ❍ neutral
- ❍ disagree
- ❍ strongly disagree

29. There was one lab that was easier/more beneficial than the other labs.

- ❍ yes
- ❍ no

30. If yes, which lab was it (one, two, three, or four) and why was it easier/more beneficial? ____

31. I think my previous anatomy experience benefited me in this course.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

32. If there was one thing I could change in the anatomy software programme it would be:

____

33. I feel more comfortable with computers now than when I began the course.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

34. I can make general use of computers.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

35. I can gather information from the World Wide Web.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

36. I can use e-mail.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

37. I find it easy to learn new software.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

38. I feel comfortable using computers.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

39. I have concerns about using computers.

- O strongly agree
- O agree
- O neutral
- O disagree
- O strongly disagree

APPENDIX G

Factor Analysis – Post Course Survey

Rotated Component Matrix

	1	2	3	4	5	6	7	8	9
1. Enough Time	0.34	0.12	0.10	-0.07	0.39	-0.16	0.50	0.39	0.06
2. Enough Open Lab	0.01	0.01	0.01	-0.05	0.22	0.13	0.79	0.04	0.11
3. Like Access From Home	0.09	0.20	-0.06	0.11	-0.03	0.77	0.12	0.05	0.17
4. Access at Home	0.16	0.24	0.21	-0.03	0.09	0.80	-0.02	-0.04	0.04
5. AccessOutside Lab	0.39	0.17	0.07	-0.27	0.32	0.57	0.11	-0.14	0.06
6. Links Logical	0.47	-0.07	0.00	-0.15	0.62	0.29	0.11	-0.04	-0.07
7. Disoriented	-0.05	0.18	0.08	0.62	-0.41	0.06	0.02	-0.12	0.10
8. Easy To Move	0.07	0.22	0.11	-0.08	0.70	0.03	0.28	-0.05	-0.03
9. Screens Cluttered	-0.22	0.06	0.07	0.73	-0.17	-0.06	-0.06	0.04	-0.02
10. Visual Distracting	0.10	-0.01	-0.17	0.83	0.00	-0.03	-0.01	0.09	-0.01
12. Text Difficult To Read	-0.29	0.00	0.02	0.77	0.04	0.09	-0.02	-0.10	-0.16
13. Orientation Confident	0.27	-0.07	0.02	-0.08	0.10	0.23	0.12	0.04	0.78
14. Manual Useful	0.28	0.04	0.21	-0.10	0.56	-0.03	-0.04	0.17	0.12
15. Navigation InstructionEasy	0.22	0.10	0.21	-0.11	0.62	0.15	0.18	-0.08	0.46
16. Computer Helped Lecture	0.83	0.05	0.10	0.02	0.17	0.11	0.03	-0.04	0.02
17. Media Use Contributed	0.79	0.07	0.21	-0.11	0.23	0.10	-0.12	-0.03	-0.02
18. Labs Related the Course	0.66	0.10	0.20	-0.15	0.21	0.08	-0.08	0.21	0.07
19. Content Interesting	0.80	0.06	0.14	-0.07	0.07	0.03	0.16	-0.10	0.20
20. Improved Web Navigation	0.29	-0.07	0.62	0.02	0.19	0.21	0.37	0.01	0.12
21. So Much Material	-0.10	0.16	-0.12	0.15	0.03	0.41	-0.34	0.43	0.34
22. Testing Identified Gaps	0.52	-0.05	0.29	-0.21	-0.14	0.12	0.13	0.29	0.12
23. Motivated	0.28	0.20	0.62	-0.24	-0.04	-0.05	0.10	0.11	0.09
25. Beneficial to Career	0.18	0.15	0.78	0.06	0.05	-0.01	-0.21	-0.02	0.01
26. SatisfiedReason	0.28	0.05	0.70	-0.02	0.18	-0.05	-0.03	0.25	0.04
27. Lab Worthwhile	0.82	0.06	0.29	-0.10	0.08	0.06	0.12	-0.04	0.07
28. Would Access Again	0.34	0.25	0.48	-0.06	-0.01	0.10	0.15	-0.43	0.32
31. Previous Anatomy Exper	0.01	0.22	0.16	-0.04	0.03	-0.02	0.13	0.77	0.00
33. More Comfort with Comp	0.11	-0.10	0.64	0.13	0.21	0.23	0.18	-0.05	-0.30
34. Can Use Computers	0.02	0.80	0.05	0.04	-0.03	0.23	0.12	0.08	-0.11
35. Can Gather WWW Info	0.07	0.82	0.07	0.08	-0.09	0.20	0.00	0.19	-0.18
36. Can Use Email	0.08	0.74	0.11	0.15	-0.07	0.33	0.06	0.26	-0.10
37. Can Learn New Software	-0.02	0.83	0.04	0.03	0.19	0.03	0.02	-0.02	0.15
38. Comfort Using Computers	0.13	0.90	0.07	0.04	0.10	0.04	0.00	0.03	0.13
39. Concerned Using Comput	-0.04	-0.67	0.05	0.19	-0.20	0.13	0.31	0.21	-0.11

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.