Information Retention as Influenced by Reusable Learning Objects

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Abstract

Reusable Learning Objects (RLOs) were developed as computer based, easily accessible, self-help tutorials and evaluated over a two-year period in a "Feeds and Feeding" class (AnS 307) supplementing traditional classroom lecture. Students often have difficulty understanding "protein quality" and its relationship to animal nutrition, and a series of RLOs were developed as tutorials for students to read and review following a classroom lecture on the subject. Pre-tests (PT) were given to students (n=56) prior to a lecture on protein quality, and the same test instrument administered again following a classroom lecture over protein quality (PT-L), followed by the students given the opportunity to review RLOs regarding protein quality and then administered the same test a third time (PT-RLO). Means scores for PT, PT-L and PT-RLO were 16.5%, 58.1% and 72.4%, respectively (P=0.01). The effects of the lecture and RLO compared to the pre-test were both linear (P=0.01) and quadratic (P=0.01) with some outcomes improved with RLOs, but some were satisfactory with only lecture. These results indicate the development of RLOs for difficult topics within a subject could be effective in increasing information retention by students. Having self-help tutorials outside the classroom for specific subjects appears to enhance student learning outcomes.

Introduction

Many educators feel traditional teaching methods are not always effective with all students. Some students are slower learners than others and have different learning styles (Ellis, 2006). Educators teaching the same course multiple times understand there are certain topics within a subject that students consistently have difficulty comprehending. However, valuable class time cannot be used for repeated remediation of students having difficulty understanding those topics. Reusable Learning Objects (RLOs) were initially developed for distance education courses (Valderrama et. al., 2005) in an attempt to reinforce difficult areas in courses. RLOs are "a discrete reusable collection of content used to present and support a single learning objective (Jacobsen, 2001)." These RLOs may take the place of regular class teaching materials, or they provide additional tutoring when added to classroom lectures, particularly when these RLOs are easily accessible. These RLOs can be in the form of text, audio, visual, graphics, or any combination of the above (Sullivan, 2001).

The issue of reusability allows students to learn through experience at their own pace. These RLOs allow repeated exposure as students need to fully understand topics. Some effective RLOs allow students to access computers and use RLOs at their convenience and take as much time as needed, repeating segments as needed; this is considered self-paced learning. The value of self-paced learning is not only that it can reach everyone anytime and anywhere, but it can teach the learner appropriately, providing the right skills at the right time (Alonso et. al., 2005). This also prevents instructors from having to use more valuable class time to further remediate a subject rather than moving to new subjects. While RLOs are widely used in on-line courses, they have not been fully utilized to compliment classroom lectures, particularly recognizing difficult to grasp learning segments.

The Advanced Distributed Learning supports RLOs approach (Marsh, 2002) since it can help reduce instruction costs 30-60%; reduce time of instruction 20-40%; increase effectiveness of instruction 30%; increase student knowledge and performance 10-30%; and improve organization efficiency and productivity. Based upon these results, there is impetus to include RLOs in education to an increased degree for both on-line and traditional classroom lectures. The U.S. Department of Defense, The Institute for Electrical and Electronics Engineers, major software vendors, higher education institutions, aviation industry, and others have indicated the need for standards in computer-based instruction. These groups have mainly focused on RLOs in the past few years (Sullivan, 2001).

The idea of reusability is usually associated with E-learning which is typically seen as being instructor-free, helping capitalize on the anytime, anywhere motivation for learning. Emphasis is not about finding instructional content from elsewhere, but a proposition with strong orientation towards learning though experiences which RLOs allow the user. This involves a pedagogical shift towards a balance that includes or even emphasizes learning as participating and contributing to the learning experience in a way which can be captured and reused by others (Collis

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and Strijker, 2002). A study to evaluate effectiveness of using RLOs found students retrieved about two-thirds of the sharable content objects that were in modules and achieved much better results on post-tests (Gauss and Urbas, 2003).

In the current study, a set of RLOs were developed to address specific problems of agricultural students understanding concepts of protein quality in a "Feeds and Feeding" class (AnS 307) taught in the fall of 2004 and 2005 using traditional lecture methodology. These RLOs were developed as self-help tutorials made available on-line for students to study after class and prior to examinations. The purpose of this study was to evaluate whether RLOs increased comprehension on this subject following a formal classroom lecture. To assess the validity of this model, students were tested (PT) prior to a lecture on protein quality followed by a lecture over the material and administered the same examination immediately after lecture as a post-test (PT-L), followed by accessibility to RLOs later that same day and tested a third time (PT-RLO) to assess comprehension of the material. Individual questions were also evaluated to determine effectiveness of RLOs.

Methods

In consecutive fall semesters (2004 and 2005) classes of agricultural science majors taking the course "Feeds and Feeding" (AnS 307) were used to assess the effectiveness of RLOs on knowledge retention on the topics true protein, crude protein and protein quality. Since prerequisites for this class include two chemistry and two biology classes and introductory animal science class, concepts of true and crude protein and protein quality had been introduced multiple times. Prior to the first lecture on the subject of protein nutrition, the test instrument was administered and is referred to as Pre-Test (PT; Table 1) and was developed to assess the knowledge of students in the class over basic elements of subject matter prior to lecture. Exams were administered at the beginning of class and were held for later assessment after completion of exams. Immediately after administering PT, a 50-min lecture on protein nutrition was delivered using PowerPoint and students given copies of PowerPoint notes prior to lecture but after PT. The lecture was completed by the end of the allotted lecture period. In the lab portion of the class later that same day (1 hr later), students were administered the same test (Table 1) after the lecture (PT-L) and availability to PowerPoint notes but prior to RLO access. After completion of PT-L, tests were held for later assessment.

Following completion of PT-L, students were given access to RLO modules, available via the internet, which demonstrated using visual and audio lessons on the topic of protein quality. Students were allowed 30 minutes to browse through the materials and discuss topics amongst themselves. The class was reassembled and administered the same test (PT) again following the RLOs (PT-RLO). After completion of the test, papers were gathered and held for later assessment.

Each test paper was randomly assigned a number so that the person grading the paper would not be aware of whether the test was PT, PT-L or PT-RLO or from year one or two. The test sequences were a requirement of the class, but actual grades on tests were not used in determining final grades of students. The grader was a professional familiar with the topic, and was provided both the PowerPoint notes and the RLO in case of questions she had regarding the material and any responses. The grader was allowed to ask the instructor any questions that were unclear, before and during grading of all tests. Papers were individually graded and returned to the instructor for statistical analysis. An analysis of variance using GLM procedure with means separation tests using LSD (SAS, 2001) was

Table 1. Questions Asked in a Pre-test/ Post-test Evaluation of Protein Quality Administered to Agricultural Science Majors in a Feeds and Feeding Class (AnS 307)

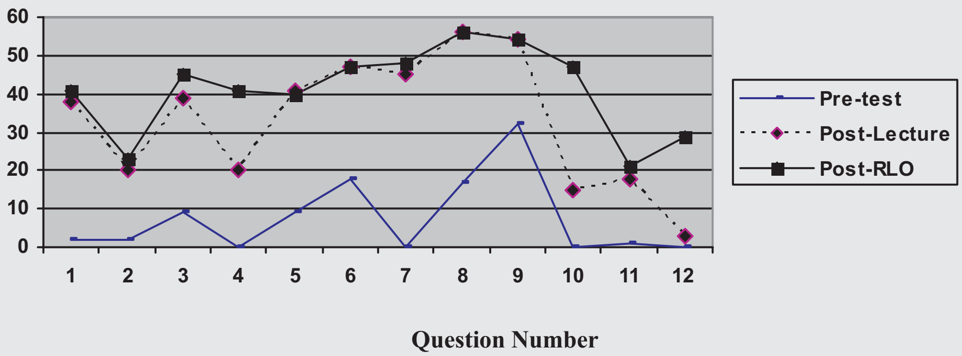
1.	Define "biological value" as related to protein nutrition.
2.	What are the differences between the molecular weights of a protein and glucose
3.	What is the difference between an essential and a non-essential amino acid
4.	What is the difference between true protein and crude protein
5.	How many amino acids can be coded for by DNA
6.	Where in the body does protein digestion start
7.	If the % N in a feed is 10%, what is its crude protein content
8.	Is it possible for a feed to have a crude protein content greater than 100%
9.	Is it possible for a feed to have a true protein content greater than 100%
10.	What is the approximate biological value of an egg to a human
11.	What is the major difference between protein nutrition in cattle and horses
12.	How is "net protein value" an improvement over biological value

Table 2. Test Scores of Students Studying Protein Quality and Given Tests Pre-Test Lecture, Post-Test Lecture, or Post-Test Reusable Learning Object

Item	N	Pre-Test	Post-Test-Lecture	Post-Test-RLO
Year 1	28	15.7	57.1	71.1
Year 2	28	17.3	59.1	73.7
Total[a]	56	16.5[b]	58.1[c]	72.4[d]

[a]Standard errors of the means were ± 15.2.
[b,c,d]Means were different (P<.01) for treatment effects, linear effects and quadratic effects.

Figure 1. Number of Correct Responses to Questions either Pre-Lecture, Post-Lecture or Post-Reusable Learning Objects



employed to analyze the 56 usable test scores of the 62 students in the two classes over two years.

Results and Discussion

In teaching a "Feeds and Feeding" course (AnS 307) for several years, problem areas each class face are similar. One difficult lecture subject for students to grasp is the concept of "protein quality" and differences between "true and crude protein." Briefly stated, proteins are highly complex organic molecules that are required in the diets of animals in large amounts. Proteins form the building blocks of many critical bodily functions and systems, including muscles, hormones, enzymes, bones and numerous body tissues. The arrangement of amino acids that make up a protein are controlled by RNA and DNA and these proteins can be several thousand amino acids in length, with molecular weights in the millions as compared to the simplicity of carbohydrates and fats; other organic macronutrients in animal diets. It is the location of specific amino acids in certain key positions that give proteins their functionality. Nutritionists differentiate "true proteins" from "crude proteins" as true proteins are made up of amino acids while crude protein refers to N content. Crude protein is a derived number based upon the assumption that amino acids, on average, contain 16% nitrogen (N) by molecular weight, and therefore, if we know the % N we can estimate the percent protein in diets by multiplying % N x 6.25.

The measurement of % N in samples is a quick, simple, repeatable measurement that is widely used. Ruminant livestock species (cattle, sheep, and goats) have the ability to utilize N or amino acids through bacterial population present in the rumen, and can assimilate N to make bacterial protein for digestion by animals. Urea (45% N) has a crude protein equivalent of 281%, but only for ruminants since it contains N, but no amino acids. Simple-stomached animals, like horses, chickens, pigs, and humans, require protein in the form of amino acids, and particularly the ten essential amino acids (twelve in chickens) since their ability to synthesize these are limited (Jurgens, 2002). Understanding differences between true protein and crude protein and its impact of various animal species is critical, but also a rather difficult concept for many students to grasp.

Results of tests on protein quality administered PT, PT-L, and PT-RLO gave remarkably similar results over the two years (Table. 2). While surprising that PT scores were so low (16.5%), this test was administered the first week of school of the fall semester. However, expectations were for higher initial test scores. Lecture and PowerPoint notes were effective in increasing test scores, with PT-L averaging an increase of 252% over PT (16.5% vs. 58.1% for PT vs. PT-L, respectively). Test scores for PT-RLO were 339% higher than PT (16.5% vs. 72.4% for PT vs. PT-RLO, respectively) and 25% higher than PT-L (58.1% vs. 72.4% for PT-L and PT-RLO, respectively) indicating effectiveness of RLOs. However, the greatest advantage of using RLOs over traditional lecture and PowerPoint notes was for questions 4, 10, and 12, indicating that the focus of RLOs may need more refining to more target specific subjects within difficult to grasp topics.

The linear effects ($P=0.01$) of lecture (PT-L) and RLOs (PT-RLO) showed improvement, with quadratic effects ($P=0.01$) also showing increases in test scores, but at decreasing rates. Students expressed satisfaction with RLOs and ease of accessing information which would be valuable when studying for tests over material, particularly the self-paced nature of this technology. Students do have different learning styles (Ellis, 2006) and RLOs allow for additional styles of information presentation in a self-paced learning environment.

Summary

Reusable Learning Objects (RLOs) were initially utilized for on-line courses as self-help tutorials to support a single learning objective. The RLO can also be used, as shown in this study, in the traditional lecture classroom to support difficult to grasp topics to alleviate repeated remediation. The different learning style of the RLO appears to compliment the existing lecture-only of many classroom situations. While test scores following lecture and PowerPoint notes showed a dramatic increase over pre-lecture test scores (16.5% vs. 58.1% respectively), access to the on-line RLOs increased test scores to 72.4%. However, the RLOs were only effective in improving tests results on specific questions. Because tests were administered immediately following lecture and RLOs, we could not determine longer term knowledge retention. Development of specific and appropriate RLOs appears to increase student learning outcomes for difficult to grasp subject material.

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