ISSN: 2167-1435
v29 n1935

Active Learning Modules to Improve Retention in Introductory Computing Courses

Lissa Pollacia
lpollaci@ggc.edu

Adrian Heinz
aheinz@ggc.edu

Kamal M. Kakish
kkakish@ggc.edu

Sonal Dekhane
sdekhane@ggc.edu

School of Science and Technology
Georgia Gwinnett College
Lawrenceville, GA 30043, USA

Abstract

This paper describes a project to improve the retention of first-year students by increasing the active learning components in an introductory computing course taught at an open access institution. By the development of Active Learning Modules (ALMs), which engage the student and produce positive learning outcomes, are shown to be beneficial for student retention. An example of an Active Learning activity is presented. The study demonstrates that the Project is successful in by increasing the passing rate in the course.

Keywords: active learning, student retention, introductory computing.

1. INTRODUCTION

Student retention is one of the most significant issues facing American colleges and universities today, particularly retention of first-year students. For the educational institution, retention is tied to federal and state funding, academic status, public perception and trust. For the individual student, retention is directly tied to do with academic success and the completion of the ultimate academic goal of obtaining a degree.

This paper explores the importance of the developing standard set of active learning modules (ALM) in the improvement of student retention by helping students succeed in introductory computing courses.

2. RELATED WORK – ACTIVE LEARNING

Lecturing is the traditional, well-established method of instructional delivery across all disciplines and at all student levels. In this method, the instructor presents the material while students passively listen and strive to assimilate the new concepts. While this method enjoys great popularity, especially in high-enrollment introductory science courses (STR, 1997), there is evidence that indicates that oral

presentations to large crowds hardly contributes to real learning (Chesebro & McCroskey, 2000). For instance, Harvard University physics professor Eric Mazur (STR, 1997) decided to "stop preaching" after discovering that his students were unable to answer basic conceptual questions in exams. Gremmels observes:

> … We in effect load our pedagogical dump truck as full as we can, back it up to the classroom, and unload it onto our students, burying them in teaching…When we use the dump truck method, we overwhelm our students with more skills and strategies than they can possibly absorb in an hour. That's our first mistake. Then we fail to give students the opportunity to practice any of the strategies and skills, virtually guaranteeing that they won't be internalized. (Gremmels, 1996)

Active Learning is an antidote to the lecture/dump truck approach. Active learning engages students and puts much of the responsibility on the student for their own learning. Well-constructed active learning modules will require the student to participate, to think, and to do meaningful activities, thus providing strategies for internalization, i.e. learning.
A review of the literature reveals that the use of

Active Learning Evidence stimulates higher-order thinking and improves student motivation to learn (Bonwell & Eison, 1991). Studies show this is true across disciplines. Students utilizing the active learning model reported greater retention of and engagement with the course material in introductory psychology classes (Smith, 2011), pharmacy education (Peters, 2011), and in computing education (Abrahams & Singh, 2010).

Research suggests that active learning leads to a variety of positive outcomes including better collaboration student-instructor and student-student collaboration (Russell-Bennett, Rundle-Thiele, Kuhn, 2010), student attitudes (Fink, 2003), greater motivation (Waston, Kessler, Kalla, Kam, and Ueki, 1996), improvements in students' thinking and writing (Bonwell & Eison, 1991), memory for information taught (Cherney, 2008), and improved exam performance (Yoder and Hochevar, 2005).

3. ABOUT GGC

Georgia Gwinnett College (GGC) is the first four-year public college to open in Georgia in over 100 years. GGC opened its doors in late 2006 with only two buildings, 11 full-time faculty, a handful of administrators and staff, and a little over 100 students. Since that time the institution has experienced tremendous growth, with the building of a new library, health and science building, student center, dining hall, student residence/housing and other academic buildings. GGC currently has over 350 full-time faculty, with 45 new hires for fall 2012. The enrollment is expected to top 9,500 students in the fall of 2012. The first graduating class was June, 2011, when GGC awarded diplomas to the first class of students who had first enrolled there as freshmen.

As GGC is an "open access" undergraduate institution, that is, any eligible student (eligibility consists of either a high school diploma or GED) who applies will be admitted. In addition, GGC serves a diverse student population, with a wide range of cultures, languages, educational preparation and experiences. It transcends all international boundaries. This diversity, combined with its explosive growth, presents a special challenge in delivering technology courses at GGC.

GGC is called "the campus of tomorrow" because its mission is to be inventive, investigational, and groundbreaking. Faculty do not hold office hours; rather they are given smart phones and laptops, and students call or text them at any time. Classes are limited to 24 students, and faculty is encouraged to learn their students' names and to be involved with each student's learning. Student engagement and the pioneering use of educational technology are two of the fundamental tenants of the institution. Because of the strong commitment to student engagement, GGC does not use the online method of course delivery; rather traditional and hybrid models of course delivery are utilized.

Unlike conventional institutions, some GGC policies challenge long-held practices in higher education. For example, GGC does not offer tenure to its faculty, which is considered to be one of the cornerstones of higher education. The college has four schools, with a 5th on the way, but no departments or discipline heads. This promotes faculty collaboration across disciplines domains. As the institution grapples

with the unprecedented growth, many of its policies and practices are evolving. The faculty have a unique opportunity to shape modern policies for an institution billed as "the campus of tomorrow."

GGC serves a five-county area in the northeast metro Atlanta area. It is located in Gwinnett County, which is now a "minority majority" county, since the sum of the minority populations now constitute the majority. Most students are admitted as freshmen, which accounts for the largest student population (53%) followed by sophomores (20%) (Kaufman, 2011).

One of the foundational courses required of every student, regardless of their major, is ITEC 1001 "Intro to Computing". This course is offered both in traditional and hybrid modes. The growth of this course moved from 30 to over 80 sections in less than 2 years. In any given semester, there may be between 1,500 to 2000 students taking ITEC 1001 and between 30 to 40 instructors. Students must pass this course with a "C" or better. Therefore it is important to student retention that students succeed in this course. ITEC 1001 is described in the following section.

4. ITEC 1001 INTRODUCTION TO COMPUTING COURSE

While GGC promotes academic freedom in teaching as one of its core values, the reality is that with as many as 40 different instructors in any given semester, the development of course content presents a challenge. Deviation from a common set of course components could yield varying results that do not correspond with the course goals and common assessments outcomes.

As a required General Education course, teaching ITEC 1001 faces a variety of challenges that manifest from having a diverse set of student education backgrounds in Information Technology (IT) skills. For example, IT majors and students that have had significant exposure to computers in high school tend to move through the material at a much faster pace and with superior performance, while those with less experience and exposure lag behind and perform at a lower level. Since the majority of students taking the course are non-IT majors, the overall student performance level tends to have a slightly negative impact on GGC's student retention rate.

The amount of work required by ITEC 1001 faculty is often inconsistent, and ultimately, inefficient due to the differences among instructors concerning course content. In addition, there is a large number of part-time and newly hired faculty. Therefore, the ITEC 1001 Steering Committee, upon analysis of the situation, concluded that creating a common set of ALMs would add significant productivity to both instructors and students. The main objective is to improve student performance and to decrease the number of students who fail or withdraw from the course. This will improve student retention because those first two Freshmen semesters are critical to students remaining in college. However, the committee felt that this project would provide the following additional benefits:

1. Consistency of instruction.
2. Improved instruction due to active learning.
3. Higher student performance in common skill set.
4. Support for instructors because the modules are developed and tested in advance.
5. Support for academic freedom because instructors can choose which activities they want to use.
6. Increased compatibility of the common assessments results.

5. ACTIVE LEARNING MODULES

The Active Learning Modules (ALM) were designed to increase student engagement in the classroom. All learning modules are consistent in design and format. A learning module was created for each chapter and each software application. Each module consists of a module description and at least 10 activities and their solutions. Each module also includes a quiz that can be used to assess the learning outcomes of that module. The module description includes learning outcomes, list of activities with a brief description and file names and mapping between learning outcomes and activities. A wide range of activities are included in each module, from pre-class reading activities, in-class think-pair share activities to post-class discussions and games. Each activity consists of two sections.

The first section gives an overview, lists the relevant learning outcomes, detailed description and references. The second section is for the

instructor's use and gives useful information to the instructors such as complexity level, estimated completion time, grading rubrics and other helpful instructions. A sample activity, based on one of the units in the Internet module, is presented in the Appendix section.

These activities were made available to all instructors teaching the course in the Fall of 2011. Instructors were encouraged to use at least three of these activities per module. Other than this requirement the faculty had flexibility in designing and delivering the course as they wished. In Spring of 2012, ITEC 1001 faculty were required to use at least three activities per module. This was the first semester in which the ALMs were fully utilized by all ITEC 1001 instructors.

6. THE STUDY AND RESULTS

Research Questions and Hypothesis

The question at hand deals with the extent to which teaching ITEC-1001 using ALMs can improve student performance, as based on students' final grades. The research hypothesis for this study is:

"The percentage of students earning a grade of D's and F's in ITEC-1001 prior to ALM instruction is greater than the percentage of students earning D's and F's in ITEC-1001 after using ALM instruction."

Percentage of students who earned grade of:	Before	After	Difference
D	5.40%	6.24%	+1.24%
F	9.42%	4.31%	-5.11%
D or F	14.82%	10.54%	-4.28%

Table 1. D and F Rates Before & After ALM

Data was obtained from GGC's Institutional Research which consisted of final grades in all ITEC-1001 sections taught in Spring, Summer, and Fall semesters, from Spring 2008 to the present. The sections from Spring 2008 through Summer 2011 are considered the "Before" group, since they were taught prior to ALM instruction. The sections taught in Spring 2012 are considered the "After" group, since instructors were required to use ALM instruction. Fall 2011 was not part of either group since it was a transition semester.

We calculated percentage of students who had a "D" or "F" each section (4,480 students for "Before", 882 students for "After"). The results are shown below in Table 1:

Analysis of the study

From the results shown in Table 1, it can be seen that the number of D's went up by approximately 1%, but the number of F's went down by approximately 5%, resulting in a decrease of slightly over 4% in the number of D's and F's.

Statisically, we are making inferences from 2 independent samples and we wish to test the null hypothesis of no difference in the population proportions (proportion meaning number of successes divided by the size of the corresponding sample).

H_0: $p_1 = p_2$
H_a: $p_1 < p_2$

Population 1 refers to the control group and population 2 refers to the population of students learning using the Active Learning Modules (ALM). We consider a "success" to be successful completion of the course (grade A-C) and a "failure" to be a grade of D or F in the course. Let us use the normal distribution as an approximation of the binomial distribution and to determine the equality of the population proportions.

The test statistic is z = -2.9078 and the P-value (the probability of the value being as extreme as the test statistic) is P = 0.0018, which produces statistically significant results using a confidence level of 0.05. Because 0.0018 < 0.05, there is sufficient evidence to reject the null hypothesis and support the claim that $p_1 < p_2$.

Thus, the proportion of student success using the ALM methods is considered greater than the proportion of student success not using the ALM methods. The ALM methods appear to be effective in this study. In other words, **we are quite confident the population success rate is higher for the ALM group due to the very low P-value.**

We also received data concerning the number of students who did not complete the course

because either withdrew from the class or made an Incomplete. These numbers also contribute to a student's success in the course, as a grade of "W" or "I" cannot be considered a successful outcome of "C" or better. These figures are shown in Table 2, below.

Percentage of students who:	Before	After	Difference
Withdrew (W)	7.63%	12.02%	+4.39%
Incomplete (I)	0.40%	0.11%	-0.29%

Table 2. W and I Rates Before & After ALM

The increase in the number of students who withdrew, however, can be attributed to a trend which we observed when analyzing the data over the three year period. The Withdrawal percentage for each Spring semester is larger than the Withdrawal percentage for each Fall semester of the same academic year, sometimes by as much as 3 or 4 percent. Since we only have one semester of data for the "After" group, and it was the Spring semester, then the Withdrawal rate is slightly skewed for the "After" group.

7. CONCLUSION AND FUTURE WORK

In conclusion, we hope that using Active Learning Modules instead of the lecture method will prove to be an example of good pedagogical practice that can be successfully applied to a variety of learning and student enrollment situations; and by reducing the DFW rate, we have positively influenced student performance in our introductory computing course. Better performance in Freshmen-level, introductory classes has a positive influence on student retention overall.

Future work is to gather more data for upcoming semesters and conduct a longitudinal study.

8. REFERENCES

Abrahams, Alan S.; Singh, Tirna. (2010) An Active, Reflective Learning Cycle for E-Commerce Classes: Learning about E-Commerce by Doing and Teaching. *Journal of Information Systems Education* (1055-3096) Win 2010. Vol.21, Iss.4; p.383-390.

Bonwell CC, Eison AJ. (1991). Active Learning: Creating Excitement in the Classroom. ASHE-ERIC Higher Education Report No. 1. Washington, DC: George Washington University Press; 1991.

Chesebro, J. L. and McCroskey, J. C. (2000). The relationship between students' reports of learning and their actual recall of lecture material: A validity test. *Communication Education, 49*,297-301.

Cherney, I. (2008). The effects of active learning on students' memories for course content. *Active Learning in Higher Education, 9*, 152-171.

Fink, L.D. (2003). *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses*. San Francisco, CA: Jossey-Bass.

Gremmels, Gillian S. (1996). Active and Cooperative Learning in the One-Shot BI Sessions", *New Ways of Learning the Library and Beyond: Papers and Session Materials Presented at the Twenty-Third National LOEX Library Instruction Conf*. Eds. Linda Shirato, Elizabeth R. Bucciarelli, and Heidi Mercado. Ann Arbor, MI: Pierrian Press, 1996, 107-112.

Kaufman, D. J. (2011, June 1). GGC Facts. Retrieved June 11, 2011, from About GGC: http://www.ggc.edu/about-ggc/gcc-facts.html

Lizzo, A., Wilson, K., and Simons, R. (2002). University students' perceptions of the learning environment and academic outcomes: Implications for theory and practice. *Studies in Higher Education, 27*, 27-52.

Michael, J. (2007). Faculty perceptions about barriers to active learning. *College Teaching, 55*, 42-47.

Peters, Michael J, et. al. (2011) An Active-Learning Strategies Primer for Achieving Ability-Based Educational Outcomes. *American Journal of Pharmaceutical Education* (0002-9459) m75. Vol.75, Iss.9, p.1-12

Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering Education, 93, 223-231.

ISSN: 2167-1435
v29 n1935

Redish, E. F., Saul, J. M. and Steinbert, R. N. (1997). On the effectiveness of active-engagement microcomputer-based laboratories. American Journal of Physics, 65, 45-54.

Russell-Bennett, Rebekah; Rundle-Thiele, Sharyn R.; Kuhn, Kerri-Ann. (2010). Engaging Marketing Students: Student Operated Businesses in a Simulated World. Journal of Marketing Education (0273-4753) Dec 2010. Vol.32,Iss.3;p.253-263

Smith, V. and Cardaciotto, L. (2011). Is active learning like broccoli? Student perceptions of active learning in large lecture classes. (2011) Journal of the Scholarship of Teaching and Learning, Vol. 11, No. 1, January 2011, pp. 53 – 61.

STR (1997). Science Teaching Reconsidered: A Handbook. Committee on Undergraduate Science Education, National Research Council. ISBN: 0-309-52275-7, p 10, 22-23.

Watson, D. L., Kessler, D. A., Kalla, S., Kam, C. M., and Ueki, K. (1996). Active learning exercises are more motivating than quizzes for underachieving college students. Psychological Reports, 78, 131-134.

Yoder, J. D., and Hochevar, C. M. (2005). Encouraging active learning can improve students'performance on examinations. Teaching of Psychology, 32, 91-95.

ISSN: 2167-1435
v29 n1935

Appendix

Web Site Evaluation

Chapter 3 – Using the Internet – Making the Most of Web Resources

Overview

The purpose of this activity is to be able to evaluate a website for its content based on evaluation criteria such as currency, relevance, authority, accuracy, purpose, etc.

Learning Outcomes

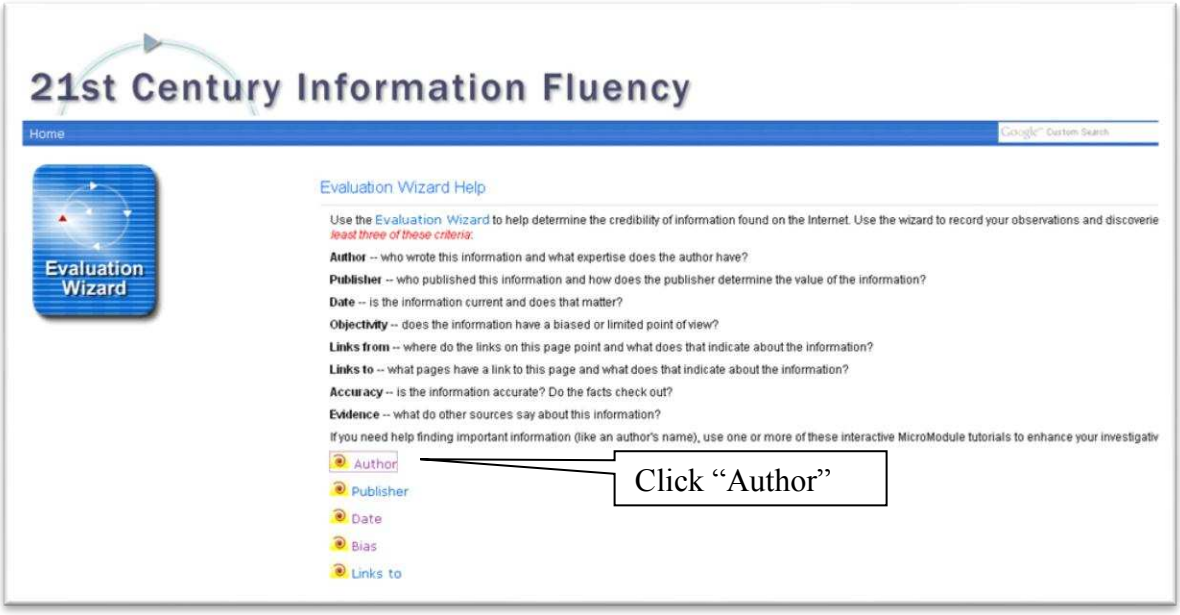
1. Evaluate a website.

Detailed Description

Find a fellow student in the class to be your teammate. Work with your teammate to complete the following activity.

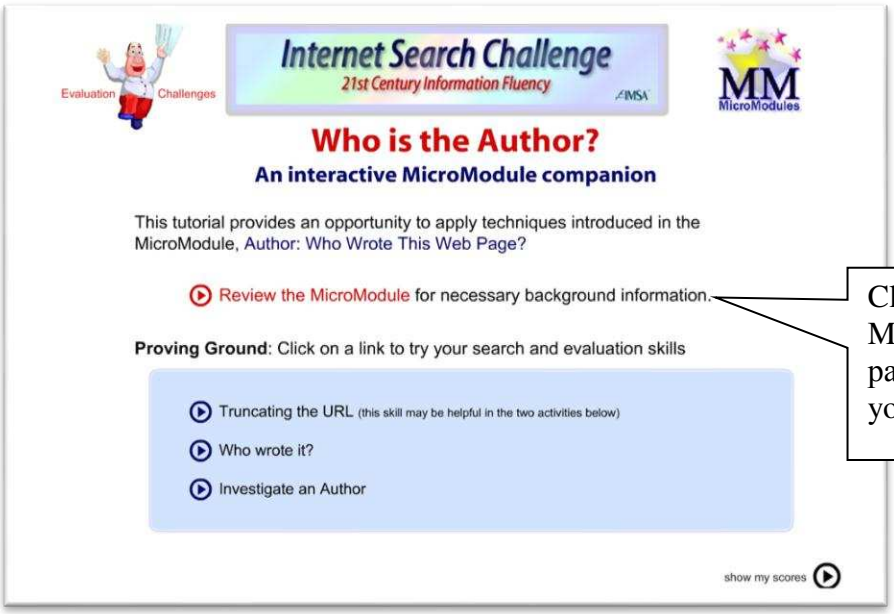
(1) Go to http://21cif.com/tutorials/evaluation/truncation.swf, and learn how to "Truncate the URL". This will be helpful when you are evaluating a website.

(2) Go to http://21cif.com/tools/evaluate/tip_help.html, a web site called "Evaluation Wizard Help", designed to show you how to evaluate web sites (shown below):



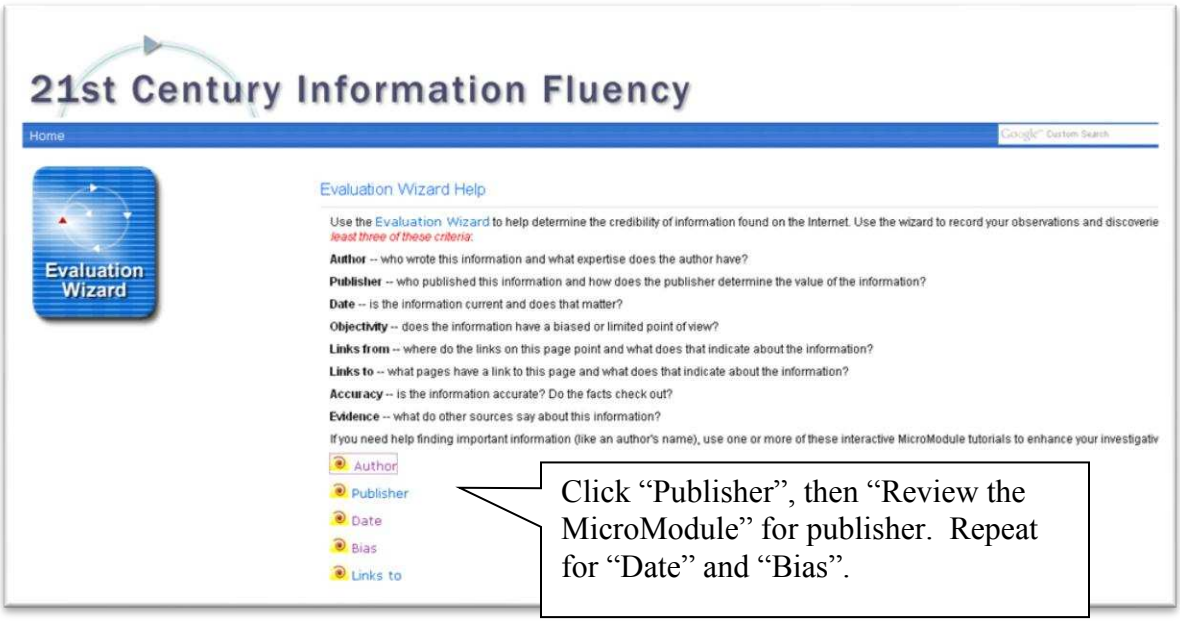
(3) Now click "Review the MircoModule" so you can learn how to locate the author of a web page.

ISSN: 2167-1435
v29 n1935



(4) Do the questions at the bottom to test your skill. Then close the tab on the browser to return to the Evaluation Wizard Help page.

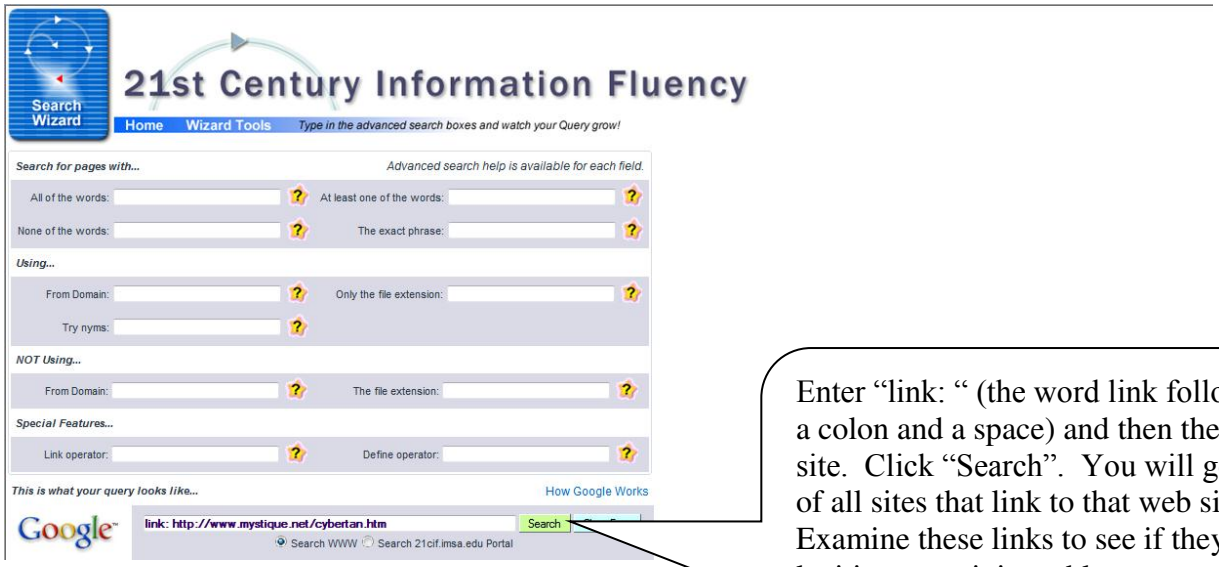
(5) Continue with the other links at the bottom of the page, e.g. "Publisher", "Date", and "Bias". All of these are important criteria for evaluating a web made.



(6) For "Links to", go to http://21cif.com/tools/locate, and scroll down to the Google search. Enter the word "link" followed by a colon and a space, then enter the web site you would like

ISSN: 2167-1435
v29 n1935

to analyze. For example:



Enter "link: " (the word link followed by a colon and a space) and then the web site. Click "Search". You will get a list of all sites that link to that web site. Examine these links to see if they are legitimate, opinions, blogs, etc.

(7) Now use the evaluation tool at

http://21cif.com/tools/evaluate/

to help you evaluate and write up a report on your team's assigned website.

Team	Website to evaluate
1.	http://www.smokingsection.com/issues1.html#smoke
2.	http://www.dreamweaverstudios.com/moonbeam/moon.htm
3.	http://zapatopi.net/afdb/
4.	http://www.peachtreeroadrace.org/participant-information/general-information
5.	http://www.google.com/jobs/lunar_job.html
6.	http://www.sandman.com/telco.html
7.	http://www.weathergraphics.com/tim/fisher/
8.	http://kidshealth.org/kid/grow/girlstuff/pierced_ears.html
9.	http://www.irelandseye.com/blarney/blarney.shtm
10.	http://www.bernardine.com/gemstones/larimar.htm
11.	http://uncyclopedia.wikia.com/wiki/Main_Page
12.	http://www.buyplaya.com/blogs/rob_kinnon/default.aspx

(8) Submit your report to the Discussion Board and be prepared to discuss it in class. (Finish this outside of class if you do not finish in class.)

ISSN: 2167-1435
v29 n1935

Instructor's use only

Complexity Level

Complexity		This Activity
Level	Description	
5	Expert	
4	Advanced	
3	Intermediate	X
2	Easy	
1	Introductory	

Estimated Completion Time

30 minutes

Suggested Rubrics

1. Students work in teams.
2. Students receive class participation points if they turn in completed work and participate in class discussion.

Instructor's Notes

1. Works best in class.
2. Students work in teams and conduct their research online.
3. The important part is presentation of the group to the class.
4. Instructor should monitor students as they work and involve all students in discussion of the material afterwards.
5. Teams should turn in their work for class participation points.

Hybrid Component

This activity works best in class. Hybrid classes could ask the students to do the work outside of class and discuss the results in class.

Completed Sample Activity

Website: http://www.mystique.net/cybertan.htm
Authenticity of this website:
Author: Information about the author is unavailable on the website. There is no About Us or Contact Us page that can provide information about the organization or the author.
Publisher: The website is hosted by DD Parodies, which is a parody site and claims to poke fun at everything.
Objectivity: Although the web page uses scientific jargon, no scientific evidence or links to any evidence are provided to support the author's claims. The language seems exaggerated and cannot be confirmed for its accuracy anywhere else.

Links To: There are several links to this page, but they are all on chat forums, with people asking questions such as "does this online tanning really work?". No legitimate web sites link to this site.
Date: A date of publication cannot be found on the web site.
Conclusion: We conclude that a person cannot take this site seriously, as it is a parody (joke) of web-based advertisement.