GENRE THEORY, ENGINEERING EDUCATION, AND CIRCUMVENTING INTERNET BANDWIDTH PROBLEMS

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Abstract – *A growing body of empirical research has implied that media seem to make little difference in education. In contrast, in the article "Distance Education Horror Stories Worthy of Halloween," David Hailey, et al. argue that Internet-based education can be dangerous to the point that it can "sometimes threaten a teacher's career." Although this might seem troublesome for researchers who maintain that media make no difference, we believe that it points to a different issue. The problems we found stem from genre rather than media choices. The point in this paper is that while media choices may matter little, genre choices are critical – substituting an essay for a lecture or an instruction set for a demonstration can have pedagogical consequences that can improve or disrupt learning.*

We further argue that the key to effectively converting traditional instruction to digital instruction is to have access to sufficient bandwidth. While it is possible in some cases to stream sound and video over the Internet, resolution is low and results are unpredictable. Distributing removable hard drives, however, permits an alternative. External drives, ranging from 10GB to 150GB make it possible to provide students with all 48 hours of "chalk talk" typically found in a 16 week course in 640X480 or higher resolution video, plus additional hours of demonstration video, 3-D game technologies, 3-D animation, interactive testing, and record keeping. In this environment, the Internet is used for interactive communication and for file transfer, while the drives are used for distributing high bandwidth content.

We have tested new educational processes employing these technologies at Utah State University and The University of Texas at Tyler and have found them to effectively solve the most important problems engineering educators face when attempting to teach over a distance.

Index Terms – Distance education, digital media distribution, genre theory and education, distributed hard drives, online learning, digital education.

INTRODUCTION

Since 1992 we have developed and tested a variety of CD- and Internet-based, multimedia modules and have presented the results in a variety of venues [1-7]. Other researchers have participated in similar studies. With few exceptions empirical research has implied that media seem to make little difference in education. For example, Milton-Benoit et al., developed a multimedia lecture that introduces students to finite element modeling [8]. Limited testing showed students performed at least as well as students in the traditional lecture on a follow-on assignment. Similarly, Al-Holou developed eight multimedia modules to introduce students to electrical engineering principles [9]. Eighteen students evaluated these lectures and found them useful and easy to learn from. Bailey et al. developed a multimedia module on phase diagrams used in a basic materials science course [10]. Roughly 40 students used the module while 40 other students had a lecture-based presentation on the material. Results from a multiple-choice quiz indicated that students who experienced the multimedia module performed as well as students who experienced the traditional lecture. Weinberger developed a multimedia lecture/textbook to teach the fundamental concepts of transport phenomena [11]. Twenty-eight engineering students used the lecture/textbook in additional to traditional lecture and performed significantly better on an exam question than student who only attended the traditional lecture. Wallace and Mutooni compared performance of students who received web-based instruction with students who attended a classroom lecture and found the average performance of students who received the web-based instruction was higher than that of the lecture-based instruction [12].

Investigators have also documented studies involving the delivery of complete courses using an alternative to the traditional classroom lecture. For example, a complete course in information engineering was developed for delivery online by Bourne, et al.[13] They found that although students procrastinated more than those in a traditional lecture course, they learned as much. Latchman and Latchman [14] describe the use of asynchronous learning networks to delivery multimedia courses to both bachelor's and master's level students. A study by Boulet and Boudreault using a more traditional asynchronous delivery-mode, television, showed students performed as well on examinations whether the material was delivered via television, traditional lecture or a partial television, partial lecture mode [15]. Faculty at the Open University have conducted large-scale trials of Internet delivered, multimedia courses compared with traditional lecture courses and found no difference in student performance based on examination results [16].

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On the other hand, in 2001, David Hailey, Keith Grant-Davie, and Christine Hult published an article titled "Distance Education Horror Stories Worthy of Halloween," that seems to imply completely different findings [7]. In this article, the authors argue that they found Internet-based education to be "unpredictable and explosive. A few troublesome online students may stage vitriolic and embarrassing attacks that can sometimes threaten a teacher's career." The article was based on an examination of more than 400 online courses taught at Utah State University between 1995-2001, and was written both by teachers and administrators. It argues that online classes are unlike face-to-face classes and are dangerous to teachers that attempt to teach them using naively designed heuristics.

Although this apparent contradiction might conflict with the publications of researchers who maintain the "media make no difference" posture, we believe that the study points to a different, perhaps more important, issue. The problems that arise in those distance education classes come not out of the online media but out of the genres the online media permit. For example, interactive discussion in a traditional class is made up of a series of short conversations; interactive discussion in an online course is made up of a series of short essays. Although the essays and discussions are in some respects similar, they are also in many respects different, with measurably different affects on learning.

If genres are important, it follows that any course being converted from traditional to digital format should be done with complete understanding of the affects of genre choices. If the media do not permit effective genres, different media should be chosen. These, then, are the three points of this paper: (1) demonstrate the importance of selecting media based on genre requirements, rather than selecting genres based on media requirements, (2) demonstrate new media that permit us to make selections based on genre requirements, (3) show how these new media can be integrated into engineering education.

THE IMPORTANCE OF GENRES

Defining Genre

Although genre theorists do not have a universal definition for "genre," generally speaking, our definitions are founded in descriptions advanced by Carolyn Miller [17]. In these descriptions she posits the argument that genres are formal and situational. More specifically and for our purposes, we define it as follows: "Genre" is a descriptor of the classification of information based on formal, and social aspects of that information as it is archived or transferred. As is usually the case with comprehensive definitions, this one makes little sense without more explanation. Briefly, we are trying to say that to identify the genre of a block of information, we must examine its form (structure and physical nature), plus how and why it is being delivered and how and why it is being accessed. Being able to examine these elements can be extremely complex and powerful, making it possible to contrast between genres as similar as rap and hip-hop music. It also makes it possible to examine and classify individual genres and arrange them into related groups (classes). For example chalk talk, PowerPoint presentation, demonstration, talking head, parental scolding, and sermons are all genres and may all be categorized under the greater classification, "lecture."

Structure and Physical Nature of Genres

By "physical nature" we mean the voice and structure of the information. For example, a manual is a written collection of informative segments, designed for quick access to solutions, and will include no self-testing components. A textbook is a written collection of informative segments that typically includes self-testing components (e.g., homework, quizzes) and is usually segmented so that information from a subsequent segment builds from information in previous segments. The voice of the guide will typically be concise, while the textbook will be more prosaic and may have narratives.

Purpose of Genres

By purpose we mean, for what reason was the work created? Television news and documentaries are designed to inform and entertain; manuals are developed to provide immediate access to technical support, and textbooks are developed to support courses.

Nature of a Genre's Use

A third approach to identifying a genre is to examine how the work is accessed. Textbook users are usually lead by teachers who help them combine the step-by-step information into a greater and more conceptual understanding of a global topic (e.g., heat transfer, quantum physics, history). Manual users will usually look a topic up in the index, then read and immediately apply the information they find in the relevant passages.

In short, a textbook can be contrasted with a manual in part by its purpose (educate broad concepts), its structure (containing homework problems, solutions and similar educational tools designed to support a class), and the manner in which it is designed to be used (students lead by teachers through the materials).

To What Extent do Genres Affect Learning

Once we have defined "genre," the question we pose is, "To what extent does modifying a genre change the quality of education?" In 1997 we ran a series of tests on new educational tools we had developed for a manufacturing engineering course [2-4]. In some of these tests, we compared student learning using analog slide presentations (slides and audiotape) to learning with digital slide presentations using identical image and sound. In this case, we were comparing identical genres with different delivery media.

In the study, we randomly divided a class of 38 students into two groups, one using a traditional medium, the other studying the identical topic using a digital medium. Students examined the topics while completing identical worksheets. Immediately after completing the modules, students were quizzed for what they had retained. The quiz included 10 multiple choice, true/false, and short answer questions. Due to the small sample size, we employed Student's *t* statistical analysis. After grading the quizzes from the two groups, we found no significant difference between the average test scores of the two groups at a 0.01 level of confidence (see table 1).

In a second test, another 38 students were randomly divided in half. Half worked in a sequential, instructional environment. The other half worked through identical material accessible in a game-like environment – while the media were identical the genres were different. To help insure that all students saw all relevant content, students filled out a worksheet as they progressed. Once they completed the module, students were quizzed for their understanding of the material. The quiz consisted of true/false, multiple choice, and short answer questions. Students using the linear module took approximately half the time of students using the parallel module. Again because of group size we used a Student *t*-test. On average, students using the sequential module missed 1.68 questions while the other students missed 3.94 questions on the same test. We determined that there was a significant difference in the average scores of the two groups at 0.01 level of confidence. The students using the game-like module B did worse. (See Table 2.)

To ensure that we had randomly distributed the students between the groups, we examined their final grades for the course. We found no statistical difference between the average final grades of the two groups.

We had hoped that by creating a game-like environment we would enhance learning. Instead, we disrupted learning.

On the other hand, changing genres does not necessarily adversely affect learning. For example, in a different series of tests between 1995 and 2000 we replaced the lectures in traditional English (composition and technical writing) classes with interactive discussion groups on the Internet. Students had no face-to-face contact and so never spoke [6,7]. All discourse was written. The results were a demonstrated improvement in learning (especially for ESL students and students with disabilities). Perhaps surprisingly, many of the students preferred the online class to traditional classes. At her graduation, one student stated that her online composition class was the best class she took the whole time she was in college.

Table 1. Comparison of data for two groups given identical assignments but different media environments.

Hypothesis:
average quiz scores of groups using different media will be statistically different.

Media Used	Average Number of Misses	Standard Deviation	Level of Significance
Traditional Multimedia	1.71	0.751	0.01 (99%)
Digital Multimedia	1.68	0.774	

Conclusion:
average quiz scores <u>are</u> <u>not</u> statistically different.

Table 2. Statistical comparison of groups A and B using sequential and parallel module.

Hypothesis:
average quiz scores of groups using different genres will be statistically different.

Tool Used	Average Number of Misses	Standard Deviation	Level of Significance
Sequential Multimedia	1.684	0.795	0.01 (99%)
Game-like Hypermedia	3.947	0.736	

Conclusion:
average quiz scores <u>are</u> statistically different.

Finally, in a series of tests (not yet published) designed to examine the value of creating genres in new combinations, we contrasted students who had access to a multimedia lecture supplement with students who had no access. The supplement recreated much of the lecture material online, making it possible for students to review the lectures. In three tests, students who accessed the supplements improved their grades 10%, 11%, and 24%

respectively (the 24% involved only three students, a very small sample size and not statistically significant).

Our conclusion is that depending on how the genres are modified, they may improve or disrupt learning.

COMPARABLE RESEARCH

There is tremendous interest in applying electronic media to education. In scores of articles in education, instructional technology, training, technical communication, knowledge management, and engineering education journals, educators have crafted a significant body of work. As a community, we have written articles describing our concerns and expectations; we've described new projects with accompanying case studies; we have presented critical inventions and discoveries, and have forwarded results from empirical, statistical research. An examination of our work, however, reveals a trend. Virtually every article focuses on the media without regard for the genres relevant to education.

We contend that as a community, we have become so focused on the media that we privilege it at the expense of genres that we know have worked well in traditional classes. For example a well-presented chalk talk provides a rich, interactive aural and visual learning environment that cannot easily be replaced with low-resolution talking heads, or PowerPoint slides and/or essays posted on the Internet.

PROBLEMS WITH EXISTING MEDIA

An important problem we have faced while developing interactive media for education is that in the past none of the media have been suitable delivery systems for some of the genres we consider critical to good learning. For example, assuming that we wish to save all of the chalk talks and demonstrations from a course in high definition video, CD-ROM and DVD are far too small, and bandwidth on the Internet is far too narrow. At 640 X 480-pixals, forty-five hours of lecture and similar demand for demonstrations will generate more content than can be held on a realistic number of CD or DVD disks. In the past, the solution has been to eliminate the video (often replacing it with online essays or PowerPoint slides), reduce its length to nothing more than a few moments, or reduce its resolution to unacceptable levels for reasonable board work and/or detailed demonstrations. Furthermore, because HTML is designed to protect the user computer from intrusion, code is awkward to use and end results are unpredictable. Finally, it is virtually impossible to integrate a project into a single package (e.g., if HTML calls up a media player, it is likely to call up whatever default player the user has installed as an additional software playing outside the project).

The Internet is a powerful educational tool, and we highly recommend it for interactive communication, grade or homework posting, and for access to resources, but for the demands of bandwidth-hungry media, we recommend a different medium. In the past two years (in cooperation with Iomega Corporation) we have researched and developed new approaches to delivering video, animation (especially 3-D animation), 3-D game technologies, high-resolution images, and similarly huge files. Because these new approaches involve using removable hard drives and because we offer it as an alternative to Internet Protocol (IP), we call the new technology the Distributed Hard Drive protocol (DHD).

In brief, DHD represents a process whereby the ideal genres for a particular class are identified. These genres are recreated in digital format using the software combinations of our choice and placed on very large removable hard drives – drives ranging from 20 GB to 150 GB with IEEE 1395 or USB connectivity. These drives are made available to students in a variety of environments, including libraries, departmental computer labs, remote campuses, or via airmail. The purpose is to support and improve both traditional and distance education.

DHD and Engineering Education

The value of our theories to engineering education becomes apparent if we examine a course and show how the theories are applied and how the content is distributed. For our purposes, we have divided a traditional thermodynamics course into chalk talk (or alternatively, PowerPoint presentation), textbook, homework, teacher-student conferences, student-student conversation, examinations (quizzes, mid-terms, and final) – with the lecture, textbook, and examinations being most irreplaceable.

Most important from the point of view of using DHD are the lectures. A thermodynamics course might include 45-or-more-hours of lectures. Including the software required to tie them all together, at 640 X 480 the video of the lectures require a minimum of 68 gigabytes. Sixty-eight gigabytes represents 140 CD-Disks, 30 DVD disks, or 150 continuous days of download time over a 58,8Kb modem.

Thinking "Genre" While Digitizing

Genres usually do not directly transfer from analog to digital. If we simply record a lecture and digitize it, we are creating something closer to a documentary than a digital lecture. Documentaries are designed as much to entertain as to inform, and as we view them, we will usually drift into a casual listening mode. By comparison, a chalk talk requires that students focus on learning. They, hopefully, concentrate on the material, take notes, and ask questions if they do not understand. Moreover, the best teachers will frequently stop the lecture long enough to make certain the students are understanding the material and are not losing concentration. It is not possible to digitally replicate all possible interactivities in a class, but we can replicate most of them and effectively substitute the rest.

We record the class using digital cameras and convert the content into MPEG files. As we are converting the material, we break it up into its most natural segments. Each segment becomes an independent file and can be handled separately. At segment's end, we frequently post a short quiz. The purpose of the quiz is not to test the student but to force the student to consolidate the materials they have seen to that point and synthesize them into comprehensive knowledge. It also gives the students a sense of how they would do on a test at that point. We view this quizzing process as the equivalent of a teacher pausing to ask the students questions to see if they are keeping up and continuing to concentrate on the lecture.

We know that in course after course students frequently ask the same questions. Once we have identified those questions, we create a resources section with short supplementary tutorials, with students or the teacher answering the questions students are most likely to ask. The resources section will also contain additional animations, problem solving opportunities, access to the teacher's notes, and, ultimately, access to the teacher or tutor.

In short, to maintain the integrity of a chalk talk as we digitize it, we cannot simply record the lecture and digitize it; instead, we need to create a new and slightly different genre that contains all of the critical elements. Like a chalk talk, a digital chalk talk must contain interactivity that permits the students to stop the lecture to ask questions and permits the teacher to quiz the students from time to time.

DHD DELIVERY MODELS

We have designed and tested three environments for delivering eight digital, heuristic models. The first of these involves attaching external drives to the teacher's computer and permitting students to network to it. The second, environment involves creating a library of drives that students may access as they need, by checking them out or by attaching them to computers *in situ*. In the third environment, drives are sent to remote students and the students return them once they complete their work. Each of these environments has specific applications, and each of them can be broken into more specific models.

Networked to Educators' Computers

DHD-based material is attached to teacher's computer, networked into the LAN and distributed to students within institute's computer lab system and into networked dorm rooms. In this case, four different models have been tested and applied or are presently being tested.

Model One

This LAN-based environment may be used to support an existing, traditional course. Students can review lectures to retrieve content they didn't understand or missed in class. Teachers can make additional information and problems available to the students (e.g., teacher may have additional demonstrations or additional problems worked out on the blackboard and available for students who are struggling with assignments).

Model Two

The LAN-model is used to restructure traditional classes. A serious problem David Hailey faces as he teaches his multimedia classes is the lack of lab time. Ideally, a class would have a demonstration component with an additional lab or workshop where students could develop their skills with an advisor/troubleshooter present. Unfortunately, Hailey is given only 50 minutes in which to present both instruction and his lab. A solution Hailey has developed allows to students to see his demonstrations and chalk talks distributed from disks attached to his computers. Once they have seen the lectures and taken the relevant quizzes, the students use the scheduled class time to develop their skills in the department computer lab in a cognitive apprenticeship environment. In a sense, the class time becomes lab time.

Model Three

The LAN-model is used is to increase learning in advanced courses. The professor of a graduate orbital mechanics course requires that students view the digital lectures and work the relevant problems before class. When the students arrive to class, they are expected to be prepared to discuss advanced issues and solve a whole new level of problems during class time.

Model Four

The LAN-model is being applied is to make courses available for students who might otherwise be deprived of access. For example, an employed student at UT Tyler is not be able to attend Monday lectures in a Monday/Wednesday course. He is prepared to do the work, and could easily pass the class except that he will miss one-half of the lectures. Within this model, the student "attends" the Monday lecture digitally and the rest of the class in a normal manner.

One advantage to this LAN-based environment is creative ownership. In each of the above cases, the faculty owns the rights to their digital content. For example, since Hailey distributes content that he created on his own time from hardware that he owns, there is no dispute over who owns the class. If Hailey goes to a new university, he can simply unplug his equipment and leave without fear of creative property disputes with his university.

Creating a Library Environment

In terms of physical size and shape, external hard drives range from the size of a paperback book to about that of a large engineering textbook. Most of them are sturdy enough to survive shipping, and mailing, and they may be shelved in departmental, university, or training center libraries, exactly like books. The most immediate advantage is that libraries long ago devised excellent methods for cataloging, protecting, and archiving knowledge. In contrast, much of our most critical information today is protected by web administrators and stored in directories exposed to the caprices of the administrators and whatever hackers, crackers, viruses, worms, and Trojan horses happen by.

Model One

One of the important problems with engineering programs, especially programs is small schools, is that if students miss or fail a critical course, they are forced to wait a year or more for their next opportunity to take the course. To retake the course in a traditional manner may be a needed remedy for some students. On the other hand, in some cases students can take the course independently, using the teacher or a tutor to advise them and test their progress.

Model Two

Professionals and students who need to review educational materials prior to taking professional exams may have access to the materials or even whole courses without taxing engineering faculty or programs.

Model Three

Disks placed at remote locations (high schools, remote campuses, and metropolitan libraries) permit students to take courses that are comparable in quality to the traditional courses they would receive on campus.

Distance Education Environment

For distance education, disks are sent to students by ordinary mail. The students' typical wait times are 24 to 48 hours. Depending on the system students have, we send either Firewire or USB drives. The drives are automatically compatible with any contemporary Windows-based system. Although such a thing would never happen, Firewire technology is such that a student could piggyback 64 – 150GB drives. In short, our distance education students will never again need more memory or more bandwidth.

One of the problems we have always had with HTML delivered over the Internet is the difficulty of knowing how student computers were going to respond to our media. Because we never knew what their settings were, or what drivers the students had installed, we never knew how a media would appear or how it would be played. Using DHD technology, our software accesses drivers we have installed using settings we have established. Because our software will access any Windows compatible program, students may use programs they already have installed (e.g., Word, WordPerfect, or WordPad for notes and reports) or programs we can bundle (e.g., MathCAD). Working much as games do, as it is booted, our software configures the computer to meet its needs, changing resolution, and accessing players and media in the manner we choose.

Virtually every page in our projects has a button that accesses an HTML index mapped to the Internet. This index contains links to teachers, tutors, and advisors as well as libraries and other technical resources. We believe that this combination of resident software with extensive broad bandwidth capabilities and access to the power of the World Wide Web makes our tool a powerful alternative to attempting to crowd content through the Internet.

CONCLUSION

Students may struggle with classes for a variety of reasons. They may have strong math skills but need to reinforce their physical intuition. Or they may be able to easily visualize a process described in a class but have problems understanding the math. In either case, students who are struggling with new ideas in traditional classes may wish to access digital version of those classes to reinforce their understanding. Our tests indicate that DHD is a valuable tool for those students who choose to use it (typically "B" students who are willing to work harder for an "A"). By accessing digital versions of their classes, students can miss a class for a legitimate reason and keep up with their peers. We have tested this scenario and found that it works well.

We saved the topic of independent, distance education until last (both in the paper and in this conclusion) because we wanted to emphasize that we developed our tools to improve education at all levels. This is not to be seen as a distance education solution but as a tool that can improve all of education. Still, as a distance education tool, preliminary tests indicate that it will work well. At this point, we have run two small tests. Both had positive results.

We are confident that DHD will provide solutions for a whole variety of distance scenarios. For example, students may take classes at home in an independent study environment or at remote campuses in a library environment. High school students may take AP or concurrent classes in schools that may not have appropriate teachers, giving students access to courses such as calculus, college physics, and/or chemistry.

The Internet has proven to be an invaluable tool for educators, but it still falls well short of being an ideal heuristic. We believe that we have developed one of the missing pieces. This year, if we can give a student a 150GB instruction set. It will cost us about $400. Next year, that same instruction set will cost us about $300. As removable drive technology advances, it becomes less expensive and more powerful. Combine the interactivity and power of DHD with the interactivity and power of the Internet, and we believe that we have an instructional tool that works.

But lest we become too enamored with the technology, we should remember that its value is in our ability to effectively retain the value of critical genres as we convert them from analog to digital.

REFERENCES

[1] Hailey, D.E. and C.E. Hailey, "Insights into Applying the Design of Multidimensional-Multidisciplinary Documents Towards the Creation of a New Literary Form." Rocky Mountain Modern Language Association Convention, Oct. 1993.

[2] Hailey, D.E., and C.E. Hailey, "Hypermedia, Multimedia, and Reader Cognition: An Empirical Study." *Technical Communication: Journal for the Society of Technical Communication*. Vol. 45/3, 1998, pp. 330-342.

[3] Hailey, C.E. and D.E. Hailey, "Evaluation of Student Preferences and Learning Outcomes of Computer Based Teaching for a Manufacturing Processes Laboratory." *Proceedings of the Annual Conference and Exposition of the American Society for Engineering Education*, July 1998.

[4] Hailey, C. E. and D. E. Hailey, "Evaluation of Instructional Design and Delivery of Computer-Based Teaching Modules for a Manufacturing Processes Laboratory," *Journal of Engineering Education*, Vol. 89, No. 3, 2000, pp. 345-352.

[5] Hailey, C. E. and D. E. Hailey, "Thermodynamic Cycles: A Multimedia, Independent Study Course," *Proceedings of the Annual Conference and Exposition of the American Society for Engineering Education*, June 2001.

[6] Hailey, D., Grant Davie, K., and Hult, C. "Online Education Horror Stories Worthy of Halloween." Special issue of *Computers and Composition*, Winter 2001, pp 387-397.

[7] Hult, C., and D. Hailey. "Virtual English at USU: a Five Year Journey." Computers and Composition Online, http://corax.cwrl.utexas.edu/cac/online/00/hult_hailey Spring 2000.

[8] Milton-Benoit, J., Grosse, I. R., Poli, C., and B. P. Woolf, "The Multimedia Finite Element Modeling and Analysis Tour," *Journal of Engineering Education*, Vol. 87, No. 5, 1998, pp. 511-518.n

[9] Al-Holou, N., "Development and Delivery of an Electroscience Curriculum for the Greenfield Coalition," *Journal of Engineering Education*, Vol. 87, No. 5, 1998, pp. 599-604.

[10] Bailey, J.D., et al., "CBL in Engineerng: Students' Use of a Learning Resource on Phase Diagrams," *Computers in Education*, Vol. 25, No. 1-2, 1995, pp. 75-80.

[11] Weinberger, C. B. and R. Mutharasan, "Fundamentals of Manufacturing – Multimedia Modules for Contextual Learning," *Proceedings of the 1998 Frontiers in Education Conference*, ASEE/IEEE, pp. 669-671.

[12] Wallace, D. R., and P. Mutooni, "A Comparative Evaluation of World Wide Web-Based and Classroom Teaching," *Journal of Engineering Education*, Vol. 86, No. 3, 1997, pp. 211-219.

[13] Bourne, J. R., McMaster, E., Rieger, J. and J. O. Campbell, "Paradigms for On-Line Learning: A Case Study in the Design and Implementation of an Asynchronous Learning Networks Course," *Proceedings of the 1997 Frontiers in Education Conference*, ASEE/IEEE, pp. 245-255.

[14] Latchman, H. A. and S. M. Latchman, "Bringing the Classroom to Students Everywhere," *Journal of Engineering Education*, Vol. 89, No. 4, 2000, pp. 429-433.

[15] Boulet, M.-M., S. Boudreault, "Using Technology to Deliver Distance Education in Computer Science," *Journal of Engineering Education*, Vol. 87, No. 4, 1998, pp. 433-436.

[16] Petre, M., Carswell, L., Price, B., and P. Thomas, "Innovations in Large-Scale Supported Distance Teaching: Transformation for the Internet, Not Just Translation," *Journal of Engineering Education*, Vol. 87, No. 4, 1998, pp. 423-431.

[17] Miller, C. "Genre as a Social Action," *Genre and the New Rhetoric*, Taylor & Francis Inc, Bristol PA, 1994, pp-39-42.