

2006-1267: AN OVERVIEW AND ANALYSIS OF ONLINE ACADEMY SECURITY AND CONSTRUCTION

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An Overview and Analysis of Online Academy Security and Construction

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Abstract

With the increasing ability for students to enrich educational experiences with online content and the move toward virtual schools, Richland County School District One has taken the initiative to develop a complete online academy. The goal of the Richland One Virtual Education Resources (Rover) Academy is to allow students in face-to-face classrooms to have access to courses not offered in their home schools as well as allow homebound students to continue to receive an accredited education. This has and continues to involve an extensive look at the best practices for the construction of such a virtual facility in terms of software engineering, hardware solutions, ease of use, and educational experience. Through the course of this paper, we present the findings of this best practices study as well as recommended steps and implementations to develop similar online academies in other school districts. Specific emphasis is placed on system security, course development, lesson conferencing, learning management systems, and logistical management culminating in a reusable evaluation for the effectiveness of the entire system that can be used to improve extant systems and guide the construction of new online academies.

1. Introduction

Since the inception of online technology, the use of the Internet as a source of knowledge has steadily increased. This increase leads to the inevitable question of its suitability as a learning tool and, subsequently, its utility as a learning environment. Under the correct circumstances, the Internet can be a valuable enhancement to a face-to-face classroom environment or even a substitute for face-to-face meeting. Online academies, or virtual academies as they are sometimes denoted, have gained in popularity in recent years^{1,2}; the increasing speed and bandwidth of home internet connections have enabled the growth of online usage and opened the possibility of using the Internet as a substitute for the traditional face-to-face classroom experience. With a significantly fast connection, video and audio streaming can bring an equivalent classroom experience to a student working from home; this is the basis of the distance learning APOGEE courses used at the University of South Carolina³. However, these courses still require in-person exams and an additional means of facilitating the delivery of assignments. Popular online academies such as Apex² and the Florida Virtual School¹ incorporate similar ideas for students who mainly attend classes by proxy from home or at facilitated computer labs.

The complete elimination of in-person attendance requirements is the source of contention for many people who see exploitations of Internet technology as far too feasible for it to be trusted as an academic environment⁴. This contention centers on the concern of accountability and integrity, terms commonly seen in information security applications. It is therefore natural to treat the design and use of an online academy as a study in information security. That is the approach that will be taken in this paper. The areas of concern will be detailed in the course of a walkthrough of the use of an online academy as either a standalone academic environment or as a supplement to face-to-face classrooms. Along with an analysis of the online academy under

consideration, a discussion of the advised best practices resulting from the study will be included at each step.

The case study on which this paper will focus is the Richland One Virtual Education Resources (Rover) Academy. This is the project of Richland County School District One in Columbia, South Carolina. Rover Academy is being developed to provide students with an increased access to educational materials and courses not generally offered within their schools. As it currently exists, Rover Academy is an intranet environment inaccessible from outside of the school district. This is to pilot its technology and determine its suitability to widespread deployment, a process expected to last throughout the 2005-2006 school year. As an initial phase of deployment, Rover Academy is offering middle and high school courses to students throughout Richland County School District One (RCSD1) regardless of the home school which they attend. Each course offered is recorded from a teacher in a face-to-face classroom and supplemented with specifically scheduled online conferencing times between the instructor and the students. Examinations are currently taken face-to-face with extra credit given to students who attempt the test again as an online only event. All course material is available online and all assignments except for in-person tests are managed by the Rover Academy software.

2. Methodology

The approach taken in this paper is the result of a complete case study and analysis of the Rover Academy system, including hardware, deployment, purpose, and implementation. The goal of this analysis was to determine the needs of the software environment to accomplish the district goals of developing an online academy that offers an equivalent educational experience to homebound students as that available to students attending face-to-face classroom sessions.

It is the consensus of those involved that this implies a great deal of interaction between the students and the instructors as well as among the students as peers. It is the desire of the project managers that the students will form a community within the online environment and interact in the same manner as students in a real classroom. This is a key component in the students receiving the greatest benefit from the service since they will not be held to the same attendance requirements as traditional students. This makes motivation for the students a key element of the online experience.

In terms of accreditation, the goal is to prove to the Department of Education that the telecommuting students receive an equivalent educational experience as traditional students. This involves a security study of the online academy to provide information assurance that assignments and tests cannot be compromised with any greater probability than they could in a classroom setting. This is the most difficult aspect of diagnosing the effectiveness of the online academy and will therefore receive the most focus.

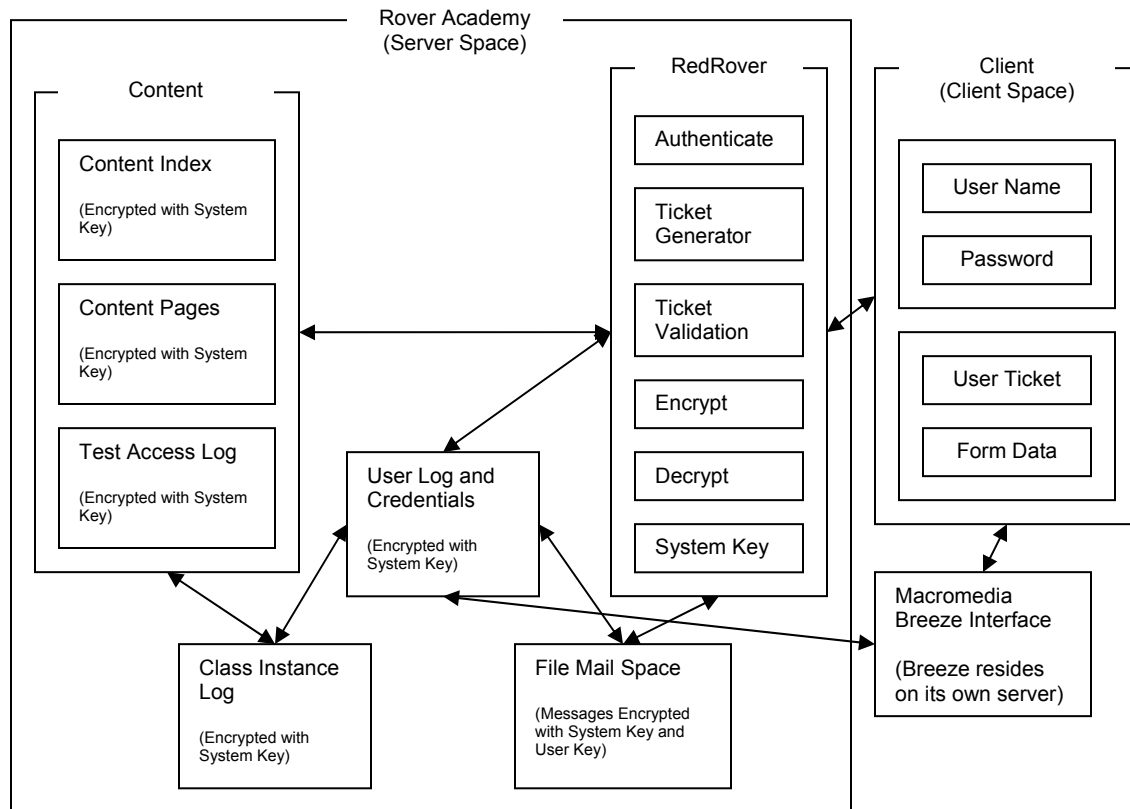


Figure 1. Architectural view of Rover Academy. Lines indicate directional communication channels and boxes indicate process modules (including sub-modules as shown; all sub-modules have communication with all other sub-modules within the module). The outermost boxes determine physical residence (server, client machine, or Breeze server).

3. Overview and Discussion

The Rover Academy system is designed to be a complete classroom environment with all necessary tools to manage an accredited education. While in most cases the implementation of most of these functions may be circumvented by a face-to-face component, the assumption made for this case study are that the teachers have access to all equipment and support to provide necessary online content while students are assumed to have only a suitable computer and high speed internet access beyond standard classroom materials; this assumption will allow even telecommuting homebound students access to an exceptional education without the requirement of being physically present even for examinations. To provide equivalence to a face-to-face experience, certain measures must be taken mainly to provide confidence in the education received by the telecommuting students.

This requires principles similar to those used for information security, namely confidentiality of content and student information, integrity of materials and assignments, availability of online resources, non-repudiation of student submissions, assurance of assignment and message delivery, and accountability at all levels of interaction. These are fundamental principles of network security, from which many of the solutions presented herein are derived.

The open nature of the online academy implies that we cannot rely upon innate network security protocols because students will be connecting from outside of the district network. It must therefore be assumed that the student computer is a hostile environment that could be potentially corrupted by malicious code such as a virus. The focus in this case is on the integrity of the online academy and the protection of student information internally. Such possibilities as spyware or keystroke recorders that compromise a student password cannot be anticipated. Prevention of data loss within the online academy system, however, can be managed; for all further consideration, any file uploaded to the system from a student computer is scanned via district software for viruses and other malicious code.

Rover Academy currently exists on a single intranet server accessible by all district computers as well as a Macromedia Breeze server which requires a separate existence for maximum functionality. Richland One is also one of the few public school districts with a connection to the Internet 2 project providing research facilities with high speed connections to information repositories at other locations, allowing district computers to access videos and other high bandwidth applications with minimal loading time. Despite its current internal existence, protection has been put in place for public access at other locations such as a home or library. The software used to develop Rover Academy was limited to all Macromedia web design software including Dreamweaver, Breeze, Flash, Contribute, and Captivate⁵ in accordance with it being chosen as a Macromedia case study. Classroom-specific materials are not included in this discussion (such as smart boards and projectors) to focus on the system itself as opposed to individual instructor presentations. The system architecture can be seen in Figure 1.

3.1 Content Development

The essential focus of content development in this context is maximizing the potential of the online platform for delivering information to students and facilitating as much hands-on interaction with that content as possible. It is the common case for instructors to maintain a web page for a course even at the high school and middle school levels; however, the level of enhancement the online content provides is not easily measurable. Used as a static repository for information, the website may be accessed to review materials near a test but it is unlikely to draw daily attention. In discussion with the benefactors of Rover Academy and those who were implementing its software, the main focus of this project was the inclusion of highly interactive, highly engaging content that would draw daily attention from students even in the absence of participation requirements set forth by instructors. Since the attendance requirements for an online academy are far less stringent by nature, there must be an essential motivation for students to return to the site and continue exploration at regular intervals. This factor is the primary reason for a limited deployment within the district as a pilot study

An example cited highly by the teachers developing the online content for Rover Academy was the Apex² online academy and its use of interactive Flash animation and video components to keep students engaged in the subject. In a similar venue, the United Streaming website⁶ is a repository of online videos suitable for classroom use for which a subscription was purchased by Rover Academy to supplement lessons with high-quality videos. Many such sites exist to service classrooms and the inclusion of such dynamic components is essential in not only

providing increased perspective to the students but also a change from static pages and less involving presentations that prove to be the downfall of most attempts to supplement class time with online content. The use of the website as an information repository is crucial and should not be ignored, but the focus of the content development for online courses should be on the construction or accumulation of engaging videos and interactive programs that will motivate students to continue learning.

An essential question in the development of an online academy is whether to purchase or develop course content. In the case of Rover Academy, the choice was to purchase pre-developed courses from the Florida Virtual School and supplement them with enhancements dictated by Richland One teachers. The enhancement for the pilot study was done for the high school Advanced Placement (AP) courses in Calculus and Literature.

The most common complaint regarding the purchased materials was a lack of student interactivity and a focus on static lessons. The purchased materials acted as a comprehensive textbook for online use but required supplemental materials for an environment lacking physical classroom time. The development of these supplemental materials is an expensive and time-consuming undertaking. Macromedia Flash is possibly the most recognized multimedia enhancement to web pages, but it is not a program that can be easily and quickly learned by someone lacking programming experience. It is therefore advisable to either train the instructors in rudimentary use of the Flash interface such that they can construct simple animations and button-type interactivity or to pair the instructor with an experienced programmer such that the supplemental materials can be constructed at a faster pace. As of the time of submission, the development had been in effect for approximately seven months and only a single course contained a significant number of interactive enhancements, tending to encourage the purchase of extant supplements in the vein of United Streaming videos or professionally available Flash programs. Development is an enormous undertaking with the benefit of being precisely what the instructor desired at the tradeoff of a very high cost of time.

3.2 Content Protection

Whether the content is developed or purchased, there is often a requirement that it not be freely accessible to the general public lest it could be stolen. The materials purchased from the Florida Virtual School were subject to this constraint in the purchase agreement and the developed content was subjected to this requirement by district policy. While on the surface this can be remedied by the use of password protection of the folder containing the material, the nature of publicly available folders (in which this content must reside to be accessed) requires that its location on the server be hidden from even authorized users whose system may be compromised. This implies that even when a user has access to the content, the user will not see the address from which this content is being delivered.

To that effect, the RedRover program was developed for use on Rover Academy. This program was developed in Macromedia ColdFusion, a programming language for the construction of dynamic web pages compiled by the server such that the client accessing the page remotely cannot view the script itself. By its nature, ColdFusion blinds the user to the activities of the script running on the server environment and the state of any variables within. It is therefore

ideal in preserving the anonymity of the content location and allows file decryption before output, allowing files to be stored in an encrypted state. The RedRover program resides in a static location on the server in the folder closest to the root that is being protected. This folder should also include password protection such that a direct access to the content will require a password to access, providing an additional layer of security should the location of the content be disclosed by some other means.

The RedRover program is called online like any other HTML page on the server. A typical system call is outlined in Figure 2 to visualize the request chain within the system from a client machine. The page name is simply redrover.cfm instead of a .htm or .html extension. Upon being called, the program asks for a user name and password before presenting a menu of courses from which to select, similar to most learning management systems such as Blackboard. Based on the selection, the internal variables corresponding to the content page(s) requested will locate the file by index and display its content (if allowed by the user's credentials) as part of the RedRover output, thus hiding the source of the content. RedRover was designed to be plug-and-play, meaning that no configuration is necessary for the system to protect content in the folder in which it resides or any of the subfolders within. Since RedRover is a process-based software system, it is infeasible to edit it directly without potential consequence; therefore, to visually display the output, RedRover utilizes a blank HTML template page that is formatted in the proper branding. This requires only a Dreamweaver template page with editable sections called "Main" and "Navigation" in which the dynamically accessed content will be placed.

Upon being called the first time, RedRover will determine that there is no index file for the content and scan the files to create one; after the index file is created, RedRover traverses the file and encrypts each target file using its internal key. This new log must be backed up in multiple locations to prevent re-encryption of the same file, which would require administrative intervention to determine the number of times the file should be decrypted to be humanly readable. It also contains an administrative function to rescan for new content or repair a damaged or incomplete index file. In designing a similar program, this is a highly beneficial asset to include, eliminating the potential human error in missing a file in the index or re-using the randomly assigned index value for two separate files.

RedRover is designed to read from its previous output for checking credentials and retrieving materials. Since this uses a standard HTML form submission, it can be spoofed by a user writing HTML code to submit different form values. While there are strict controls over the form input that is accepted, an attacker could spoof higher credentials and masquerade as an administrator and gain undesired access. To correct this problem, the RedRover produces a ticket verifying that the form output (including the user name and credentials) came from the RedRover program itself. This is accomplished by producing a cryptographic hash value from the information output into the HTML form along with a secret key known only to RedRover. Since RedRover is the source and destination of this key value, there is no issue of key distribution and the RedRover program periodically updates its own key to prevent compromise should a key value be correctly guessed. By producing this hash value using the MD5⁴ or SHA-1⁴ cryptographic hash algorithms and a random key of variable length, an attacker would have to correctly guess which hash value corresponds to the valid ticket for the false form input. Either hash algorithm produces a value that is well over 100 bits in length, meaning an attacker has less than a $1/(2^{100})$

chance of guessing correctly. For readers unfamiliar with cryptographic advantage, an attacker would have a greater chance of winning the pick-4 lottery four consecutive times than guessing the valid ticket. Should a valid ticket be guessed, there is only a small window of time in which that ticket would be valid before the RedRover changes its key again, forcing the attacker to start over. The user name used by an attacker would also have to be registered with the correct permissions within the RedRover database for access to be granted anyway, meaning an attacker would have to know the user name and credentials of a true administrative user to even attempt to spoof the system in the first place.

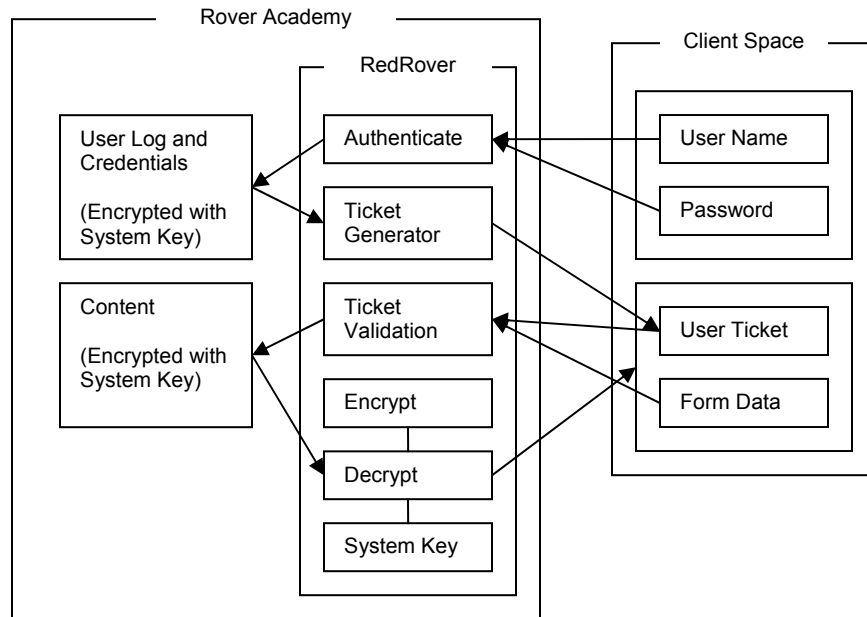


Figure 2. This is a process diagram of the RedRover system for a typical content request. The process is initiated by a client request for authentication using the given user name and password. Information flows from module to module according to the unidirectional arrows shown.

3.3 Classroom Learning

Providing an equivalent to classroom learning is a matter of adequate bandwidth. With the proper tools, the majority of the classroom experience can be captured by the online environment. Video streaming is a common application in distance learning environments. Archival video capturing is also an important benefit of online education. The main requirement for video access is storage space, which can be handled by a dedicated server. Many specialized devices exist to capture multiple perspectives on the recorded lesson, such as those manufactured by Mediasite. The Mediasite device is capable of recording computer input along with live video, tracking both the instructor and presentation simultaneously. The output of the Mediasite device is interactive, allowing the viewer to focus on either input, making it ideal for capturing lectures. A sample of this output is available on the Mediasite home page⁷. This type of output is ideal for use in supplementing face-to-face classrooms with online content. The drawback to the Mediasite device is the lack of interactivity during the recording of the lecture. Without a

separate system for streaming the lecture and providing an audio/visual connection for the telecommuting student, Mediasite systems are not suited to classroom-type discussion online.

As advocated in other sections of this paper, the use of Macromedia Breeze is recommended for online-only classroom sessions. Breeze is capable of handling multiple connections and is typically used for teleconferencing in business environments. This makes it ideally suited to use in an online academy since constructivist practices encourage inquiry and discussion as preferable to static lecture⁸. Breeze is a complex Flash program designed by Macromedia; its capabilities in regard to online classroom lecture/discussion are the ability to support video chat as well as audio alone and text messaging. Breeze also supports the ability to upload files to the conference and allows an instructor to take control of another participant's computer for demonstration at the participant's request and permission. Computer input can also be routed into Breeze, providing dual-content delivery similar to the Mediasite device. Breeze sessions can be recorded via Breeze Live, allowing for the same online delivery and archiving as the Mediasite output.

For the purposes of interactive lessons, Breeze provides much greater functionality and allows interaction at recording. Breeze also provides a level of accountability that Mediasite cannot in that students may be required to sign into the Breeze session, which will provide some attendance record that downloading of static content cannot. For video interaction, each student must have a webcam or at the very least a microphone. Breeze also requires a standalone server to effectively handle conferencing of a large number of people. While it is technically possible to house a website on the Breeze server as well, it is difficult to configure and more cumbersome than using a separate server for content deployment. Rover Academy utilizes a separate server for Breeze; this server can also be password protected and subjected to firewall protection.

3.4 Student/Instructor Conferencing

In an online academy, appointments and personal office visits may not be possible for telecommuting students. Therefore, an instructor must be able to maintain online office hours, a scheduled time period in which an instructor is expected to be available online. While text messaging may be suitable for some questions, it is insufficient to provide a comparable experience to phone or in-person meetings. Fortunately, Macromedia Breeze is capable of providing text, audio, and/or video connection as well as recording input from a computer or allowing an instructor to remotely control a student's computer with the student's permission. Breeze also has the ability to allow all participants to edit the same file attached to a session and contains an application similar to a white board, meaning an instructor and student can co-edit the contents of the screen for brainstorming or further exploration.

In the search for alternative options to using Macromedia Breeze, there was no other extant software package that provided all of the functionality of Breeze. Breeze is itself constructed from Flash and deployed on a standalone server, but the amount of time and effort required to recreate a comparable package for deployment is not worth the investment compared to the cost of purchasing and maintaining a Breeze server. Additionally, with the relatively small added cost of webcams for instructors, the Breeze system can provide an effective tool for interactive classroom lessons, providing two key components of online academy functionality with built-in

server protections and the ability to further protect the server by firewall deployment. Since the Breeze server is standalone (at least in terms of Rover Academy and the general situation for deployment), even a compromise of the server would only interrupt live service until it was reset; there would be a minimal effect on archived online content and no loss of mission critical data.

3.5 Messaging System

A means of communication is necessary beyond classroom interaction. This is required for such things as setting meeting times, answering questions, and assignment submission. The latter requires the most care and overlaps the use of a dropbox system. In a dropbox, the assignment is submitted electronically into a folder with a timestamp upon submission. This helps to verify that an assignment was submitted on time and stores the file in a known and protected location.

A survey of contributing teachers, however, led to the need for students to interactively complete sample tests and essays online without dissemination of an electronic copy. Providing the students with an electronic file (in Microsoft Word for example) allows limitless and potentially unwanted distribution of the file. By providing the content as part of the protected system content, however, and allowing the students to complete assignments within the web browser solves several problems simultaneously. It provides access control for the content through integration with the RedRover system and eliminates the requirement for external software on the student's home computer environment. It also allows for content to be protected from copy-and-paste dissemination via embedding the questions or the entire form within Macromedia Flash, as opposed to HTML in which the source can be viewed and text can be highlighted and copied.

As a caveat to the use of Macromedia Flash, the file can still be downloaded, but in order to run, the program should be dependent upon an authorization from the server that is contingent upon possession of a valid RedRover ticket; this is easily coded and requires use of an illegal Flash decompiler to circumvent. It is possible that such software exists, but this piggybacks the security of a typically small-scale online academy onto product control for a large corporation with far more resources and motivation for stopping the dissemination of such a decompiler, which is a favorable situation for the online academy.

To provide this functionality, a full and reliable integration of the dropbox and content provider is required. In fact, the most efficient solution to the problem was use of a file-mail system for messaging. By constructing a file-mail system that requires ticketing from RedRover and accepts constrained inputs similar to a standard e-mail program, it is possible to construct a robust mail/messaging system that builds upon the extant username and password system the students use to access the content initially. Login is kept current via ticketing and security is maintained to prevent unauthorized or simply unwanted messages from entering the system. The messaging system stamps all transactions with the system time, preventing timestamp tampering at the user level. The messaging system can also be accessed similar to an internal e-mail environment for correspondence to and from instructors and students. This also provides a convenient method by which teachers can offer feedback via the standard "Reply" function common to e-mail systems. All mail is encrypted for storage using a combination of the system key and a user key in the Advanced Encryption Standard (AES) cryptosystem⁴ derived from user

data and a random function, meaning that possession of either key alone is insufficient to access any mail text files even if the location or a single key (such as the user key from a compromised insider) is known.

3.6 Peer Interaction

One of the essential factors in providing a comprehensive learning environment is peer interaction among students. In an unofficial survey of students at the University of South Carolina conducted by the head of the Department of Computer Science and Engineering, the consensus was that online interaction is limited to what is required by the instructor. This means that interaction on a discussion board is almost always maximally constrained by the number of posts required by the instructor. The inclusion of discussion boards is straightforward in terms of technical accomplishment, requiring policy to provide their utility in a learning environment. This is not a well-solved problem and requires a way to motivate students to initiate discussion threads on their own, something that most students are reluctant to do.

The policy decided for Rover Academy was to require that at least thirty percent of the assignments for each class utilized the discussion board in a debate fashion. This means that students are divided into pro and con viewpoints and must successfully defend their position to receive full credit. The purpose of this is to encourage meaningful contribution above the simple statements of “I agree” and motivate the students with competition and the goal of proving their viewpoint. The assignment into pro and con teams is left to the instructor’s discretion. It was also decided among the instructors in the pilot study that assigning the same grade to all participants on a team reduced morale for higher level students who felt that their grade would suffer with the interaction of unmotivated students. This approach was piloted for the AP English Literature class and, with a sufficient depth of initial topic, proved highly successful with students posting multiple positions, arguments, and rebuttals, exploring the topic similar to an in-class discussion though over a longer period of time. The time frame suggested by the AP Literature pilot study suggested approximately three days for most of the meaningful contribution, allowing students enough time to think through the arguments presented and explore in sufficient depth to address the topic.

3.7 Learning Management Systems

Several of the tools and suggestions herein are partially addressed by extant learning management systems such as Blackboard⁹ and Ucompass¹⁰. However, the development devised for Rover Academy was aimed at constructing an independent system that could be used on any server (with an additional Breeze server required for live streaming) or a combination of servers. Current learning management systems are suitable as classroom supplements but are not capable of the robust applications desired for a completely online classroom environment. The one omission in the specifications covered thus far is a grade management application, which can be addressed within the context of roles for the system.

The general assumption for the overall system is a role-based access system with three primary roles: student, instructor, and administrator. Other roles can also exist with alternate combinations of permissions such as an administrative overseer, capable of viewing all content

but not altering other user's settings. Instructors have the ability to create class instances and students can then enroll in those classes (with administrative permission). Within the class instance is the capacity for instructors to assign and maintain grades. Similar to protected content pages and file-mail messages, grades are stored as encrypted meta-data, double encrypted with the system key and the instructor key under the AES cryptosystem. Student administrative data such as social security numbers and other sensitive information is not required for use within the online academy system and can be handled by alternate, even offline systems maintained by administrators. Students can be assigned a system-only student number or username that will serve to distinguish them within the system, from which grade data and relevant information can be exported without confusion. With such measures in place, the Rover Academy system serves as its own complete learning management environment capable of serving as many students as space allows without the licensing constraints of extant systems.

3.8 Assignment Access and Completion

The one outstanding issue that remains is the assurance of completing constrained assignments online. Some assignments fall under the constraints of timed responses and the inability to change submitted answers. For instance, a student should not be allowed to take the same test twice or complete an assignment after the time period has expired. It should be here noted that there is no comprehensive physical security equivalent in the online environment that equates to physical monitoring of a teacher within the classroom. This section will focus on the security of the software environment and add the assumption that the Breeze server and webcams can be used to record whether students are physically doing their own work. For the pilot study, online tests were conducted to test the system only within school computer labs with a proctor. It should also be mentioned that the ideal use of this system is an open-book exam since student access to the online academy itself implies that the student has an internet connection that would allow access to all online information. Open-book exams are more concerned with solving real problems rather than memorization, which is also better training for real-world situations in which relevant resources can be located and knowing where to find information is more essential than memorizing the information itself.

The security of test administration must be handled on the server side since it must be assumed that any software running on the client (student) machine can be compromised or spoofed. Similar to previous functions, the authentication of this process is determined by ticketing. Within the class instance, a teacher can add an assignment and set the constraints on the amount of time a student has to complete each exam, the start time for the exam, and the expiration of all access to the test. The student is given access to the test (or quiz equivalently) at the time the authorized access begins by inclusion on the class list and absence on the assignment completion list. Therefore the student can submit the test only once and, at submission, the result will be sent via file-mail to the instructor and the student will be added to the assignment completion list. The use of file-mail transfer to send the test implies that a student could falsify the test and send either an additional copy of the results, which motivates the inclusion of a test key assigned as the instructor generates the test instance. This test key is used to process a legitimate test submission and proves that the test results came from the proper source. Upon instructor access, the file is decrypted to provide an assertion that the test submission is legitimate; this is similar to a message digest system common in security protocols.

During the testing, it must be assumed that interruptions to the student's internet connection can occur by accident or intention. The access to the test content is therefore determined by possession of a valid ticket during the time period in which the test is active (or alternately while the time limit has not expired on that particular student's access if the test is not required to be taken at a specific time). The student must possess only a valid ticket for access similar to all other content access; there is no other maintenance requirement on the client side in order to prevent tampering and spoofing. A small JavaScript clock application is provided within the system to alert students to the time remaining by synchronization with the server access time constraints. Any submissions made after the expiration time will not be accepted or can be accepted with a notice of late postmark as dictated by the instructor. While this function cannot be relied upon for all browsers, a META tag has been included in test pages as a courtesy to automatically submit the test answers as provided if the time limit is about to expire. Time spent offline due to connection interruption is still deducted by the server from the time a student has to complete the test. Grievances with this policy can be initiated by the student and should be addressed by the individual instructor; instructors have the discretion of allowing an additional access to the test should the student have a legitimate reason for failure to complete it.

4. Conclusion

In its current state, the Rover Academy is being subjected to student and instructor use tests to determine its effectiveness as an online learning system. Upon completion and revision, the system will be subjected to review as an officially accredited educational tool. The study conducted herein was aimed at providing all foreseeable functionality dictated by the substitution of face-to-face classroom interaction with an online environment for learning. The recommendations herein were based upon the goal of a highly secure and highly integrated learning environment and typical district budgetary constraints (the purchase of a single server with ColdFusion capabilities would run approximately \$2000.00 as well as access to a Macromedia Breeze server through the recommended one-time purchase of \$6000.00 or \$750.00/month subscription price plus the cost of purchased content, which varies according to class need). The security study of the online academy has yielded several innovative solutions to the problems of transferring responsibility of physical interaction to an Internet environment. The assumptions made for the systems herein are that typical network security measures are in place that still allow anonymous form submission and that all uploaded files are scanned for malicious code prior to storage.

5. Copyright Information

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6. Acknowledgements

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