Creating the Online Learning Community for Distributed Education Doctoral Programs

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Abstract – Many colleges and universities now readily embrace the Internet as a viable distributed learning delivery model. As such, the Internet is a valuable tool to attract the highest quality students to an institution's academic programs. However, while this may work well at the undergraduate or master's level, many institutions maintain a required residential or internship requirement as part of a doctoral program. This interactive learning community is a vital aspect of a quality doctorate program. This paper presents a means to create an online learning community to replicate the residential graduate student experience. This goal is accomplished through the collaborative use of videoconferencing, video/web streaming, and communication applications. The paper also illustrates two examples from a Modeling and Simulation and an Instruction Design and Technology doctoral level curriculum.

Keywords: Distance Learning, Distributed Education, Learning Communities, Videoconferencing, Internet

Background

The distance learning program at Old Dominion University (ODU) dates back to the 1970's beginning with a partnership with the Eastern Virginia Medical School. This early system used the local microwave network to deliver content from instructors to students. In the mid-80's ODU began using analog satellite as a broadcast methodology and in 1989 ODU purchased its first analog Ku-band satellite uplink antenna. In 1994 the Office of Distance Learning's TELETECHNET system migrated to digital satellite technology and began to rapidly expand the number of courses offered. In 1995 ODU began pilot programs offering courses via the newly emerging two-way videoconferencing technologies. 1998 marked two major milestones with the experimentation with Internet or web streaming methodologies and the migration of the satellite system to an aggressively multiplexed MPEG-2 stream. In 1999 the Gornto TELETECHNET Center opened with four floors of classrooms, studios, control rooms, offices, technical support, and video production facilities. The TELETECHNET program now has over 27,000 annual registrations and delivers content via MPEG-2 digital satellite, ISDN, ATM and IP videoconferencing, Real Player, Windows Media, and MPEG-4 Internet streaming, CD-ROM, and DVD.

The Gornto Center is designed for the efficient delivery of content. The master control room is at the center of the design and houses all routing systems, video conferencing bridges, monitoring, and quality control consoles. A control room operator is available to monitor, switch video sources, control audio levels, and provide general technical support to each instructor during class. Training is provided for every faculty member on the idiosyncrasies of each delivery format. The instructor is also provided with a number of tools including a PC workstation, overhead document camera, laptop interface, electronic whiteboard, and DVD/VHS players. The instructor is able to hear the questions from satellite students, see and hear the questions of videoconferencing students, and read questions from the online students via a customized chat application. The classrooms range in size but all have a common design, a traditional layout with rows of desks facing the front of the classroom where the

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instructor's desk is located. This instructor-centered layout is very effective for lectures and directive or problem solving pedagogies in undergraduate and many masters' level programs.

However, the current design is very ineffective for student centered seminar styles or the constructive pedagogies of upper-level masters' and doctoral programs. In these scenarios the instructor is no longer the center of the class and serves more as a facilitator for the discussions between students and groups of students. While the delivery methods now being used are able to reach a great many students that would not be able to attend a traditional class. There remains a large population of students who could not attend at a remote classroom. While many of these students could participate in class via an Internet streaming format, the one-way nature of video streaming does not lend itself well to the constructivist or seminar styled Ph.D. level courses. These courses require a higher level of instructor-student and student-student interactions, or the creation of a learning community.

The purpose of this study is to research and create a learning environment for the delivery of interactive doctoral level programming and the creation of a distributed learning community among these students and instructors.

Theoretical Framework

The community of learning or doctoral residency is a critical component of most accredited doctoral level programs. The University of Pittsburgh (Pitt) states that their full-time residency program "…affords the student the opportunity for daily professional interaction with faculty and other Ph.D. students…" [30]. Pitt is also flexible in these requirements (a combination of part-time and full-time) recognizing that not all of their students can live on-campus or attend school full-time. Northeastern University has a similar philosophy in their criminal justice program's residency requirement which reinforces the real-world application of the principles taught in class, affords the ability to make contacts in the field, and to create the opportunity to learn more outside of the classroom environment [19]. From the medical perspective, along with the gaining of knowledge in the real world, another goal of residency is to contribute original research to the existing body of knowledge, especially in relatively new disciplines [28]. Regent University expands on these ideas by describing that the purpose of their doctoral residency is to ensure student interaction, interaction with faculty, engagement in scholarly debate, participation in cultural events, and to engage in coursework [23]. These examples of residency build on a common thread, doctoral students in a quality programs require a high level of interaction between content, faculty, and each other to enhance and develop the learning experience.

While the benefits of residential programs are well documented, so are the benefits of distance learning and distributed education. Distance education existed in some form since the early days of postal services and has progressed as communication technologies have developed. The late 1800's marked the increasing popularity of correspondence schools, while the use of radio was the primary distance learning tool from the 1920's to 1950's, the use of television and satellite began in the late 70's and continued through the 80's [18]. However, it was not until the mid to late 1980's before distance learning programs began to be accepted as a viable alternative to traditional classroom education and began to experience significant growth [29]. In the early 1990's television and satellite were still the delivery methodologies of choice for distance learning programs [31]. By 1997 new trends had emerged, 79% of four-year public institutions had initiated some form of distance learning program with 50% of those being online course offerings [5]. The common theme of these findings are the upward trend of the growth and demand for distributed and distance education by students who could not attend a traditional classroom environment. This is especially true as technologies continue to allow for the cost-effective delivery of content and greater access to potential students. By 2005 institutional spending on distance education will increase to $11 billion up from $4.5 billion in 2003, the Internet will continue as the dominant delivery methodology, and the nation's current higher education infrastructure will not be able to support the future demand [12].

In this environment the Old Dominion University seeks to expand course offerings to include doctoral level programs by recreating the traits of the traditional residency learning community. Many studies show that tools such as Learning or Course Management Systems, webconferencing, chat applications, and threaded discussions are successful means to build communication into the classroom environment. For instance, California State University's efforts show that given a structured environment, student discussion board posts can be very focused and can be used to engage other students in numerous discussions [22]. This research is supported by work from Regent University which shows that structured discussion environments, along with the other tools provided by Blackboard, can create a positive, asynchronous learning environment [26]. They also found that by using a different student each week as the board's moderator, the level of student's sense of community was enhanced. Rovai builds on these findings by expanding the original sample set and generalizes the conclusion; "discussion boards… can support discussion that are both task driven and socio-emotional driven in origin. Thus being able to …sustain classroom community at levels similar to levels experienced in traditional face-to-face courses…" [27]. Research resulting from a joint effort by Microsoft and the University of Washington yields an important distinction between synchronous chat applications and asynchronous discussion boards [4]. Their study shows that the real-time application yields strongly opinioned quick responses, with the discussion board usage leading to higher-level focused comments.

Research from the University of Alberta using computer mediated communication (CMC) shows that the use of computer conferencing served as a viable tool in the creation and maintenance of a community of learning or inquiry [9]. This Community of Inquiry is based on three types of interaction, Social Presence, Cognitive Presence, and Teaching Presence. Additionally, computer conferencing combines these interactions though supporting discourse, setting climate, and selecting content. A similar study from the University of Calgary showed that the instructor should play a significant role in the structuring of the online environment and reinforced that student learning is enhanced through collaboration and teamwork [15]. Anderson, from Athabasca University, also describes student interaction as a critical component of online and distance education and quotes Wagner's 1994 definition of interaction [1]. "Reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another." This mutual influence can be facilitated by a number of tools, such as computer or webconferencing and discussion boards. Further, Anderson theorizes that Garrison's, Anderson, and Archer's three modes if interaction or presence will be easier to achieve as the power and storage capacity of computers and the speed and reliability of computer networks continue to evolve.

Recognizing that loss of face-to-face interaction is a strong argument against online communities, Hiltz, from the New Jersey Institute of Technology, presents evidence that keeping group sizes small, well thought strategies, and instructor mentoring can overcome these temporal challenges [10]. In another similar research project, a means of quantifying the measure of social presence in educational computer conferences was established [25]. This measure could be used to further substantiate the student's sense of community in the conference and how that community leads to higher levels of cognition. A recent study builds on this idea of learning communities further by studying the individual roles of students in the online group [8]. This study shows that in a successful online environment, students must assume greater responsibility in their engagement with the content, instructor, and each other. Research from Spring Arbor University and Regent University also shows that not only is interaction important, but it must also be coupled with immediacy [33]. This immediacy is defined as the reduction or elimination of the perception of distance between members of the online learning community. Reduction in class size has been a popular theme in recent years and is echoed by online community practitioners [13]. Examples includes the University of North Florida which advocates a class size between 15 to 30 students [14], and the New Jersey Institute of Technology advocates a maximum of 25 students per class [7].

Numerous examples show the direct application of these online community considerations in the specific field of engineering, technology, and applied science. For instance, joint research between Rensselaer Polytechnic Institute and the University of Texas-Dallas show that online data collaboration and chat applications increase students' understanding of circuit design [16]. Electrical and Computer Engineering students from the University of New Hampshire felt that the most significant advantage of the online format of their Electromagnetic course was convenience [32]. This same sample set also stated that the main disadvantage of the format were the technical problems associated with Internet content delivery, a quality aspect to be considered in system design. Additionally student assessments from a computer programming course from North Carolina State University show no significant difference between life-long onsite and online learners [7]. This research also showed that online undergraduate students actually scored higher on these tests than their traditional, on-campus counterparts. A more recent survey conducted by the New Mexico State University also shows that students had a generally positive experience in the online environment [6]. Also, these students reported the main disadvantage of the format was the difficulty understanding content and that the online technology was a distraction. Work by the mechanical engineering department at Pontifical Catholic University of Rio de Janeiro, shows that commitment of students and co-responsibility between instructors and students for the accomplishment of course objectives, is required for successful online engineering programs [2] & [3]. What these individual research results demonstrate is the common ground that exists between engineering and applied science distance education and the delivery of generalized content via a distributed education methodology.

The synthesis of these research studies and reports illustrate that the learning community is an essential aspect of higher-level learning and that this community can be created online through the use of technology and thorough instructional design.

Project Objectives

After an analysis of the theoretical framework, the next phase of this engineering and technology learning community design was an examination of the system's goals and objectives. This design approach focused on three specific Ph.D. level courses that required a high level of interaction, two Modeling and Simulation and an Instructional Design and Technology seminar. Working with the three faculty members the objectives and expectations of each course was discussed and outlined. Three aspects are used to describe and analyze these pedagogical objectives: the Type of Learning, the Control of Learning, and the Focus of Learning. Part of the design process is the illustration of these objectives to describe expectations and goals between designers and faculty.

The Type of Learning measure depicted here is a modification of Reigeluth and Moore's cognitive model combined with aspects of Anderson's revision of Bloom's Taxonomy as described by Pohl [24] & [21]. The figures used in these descriptions are also modified from Reigeluth and Moore. Memorization is described as the process of learning and recalling facts, Understanding is the comprehension of processes and the why of that process, Application is the use of learning to accomplish a task, while Creation is the combination of several learning modes to build a new idea. Of these four leaning types, the objectives of these engineering and applied science courses focused on the higher level thinking task of Application and even more so in the task of Creation. Figure one depicts this scale and the focus on Application and Creation, the darkened shaded area shows emphasis leaning towards the Creation learning style.

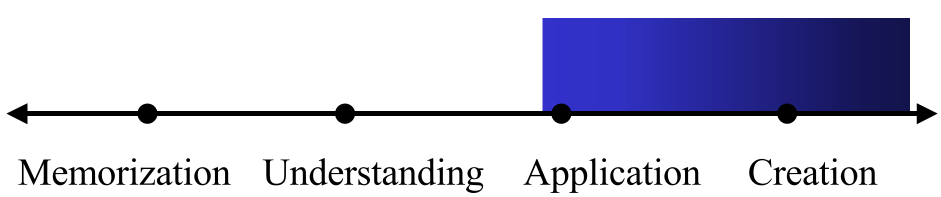


Figure One: Learning Types
The higher thought process that is an objective of the online communities of these courses is visually described using a modified Reigeluth and Moore model.

The Control of Learning is another aspect of the course to consider. For instance a typical lecture is very instructor or faculty centered, a graduate seminar is much more student centered. In the opinion of the instructors of these three courses, the higher level graduate masters' and doctoral level programs require the students to take responsibility for their learning. The student has the ability to research, critique, and discuss specific aspects of the content that are of particular interest or relate to dissertation goals. In these courses it is planned that the instructor will serve more as a moderator or facilitator for the discussion between the students. This student-centered approach is emphasized through individual literature reviews in the Instructional Design course and the group projects of the Modeling and Simulation courses. This description is illustrated in Figure Two.

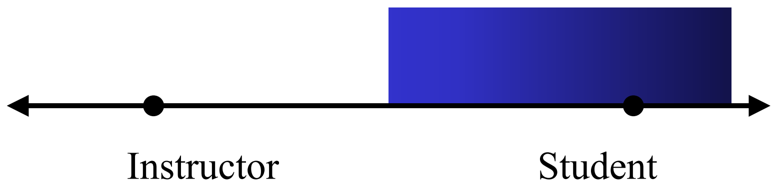


Figure Two: Control of Learning
It is the intent of these courses to focus the learning on the students who will be responsible for the quality of the discussions and learning.

Another aspect of these courses is the focus of the content. One measure of this focus is a range between an Interdisciplinary or a Domain concentration. An interdisciplinary focus would be the blending and combination of various fields of study, while a domain focus is the concentration in a specific field or a component of that field. The second measure of the content focus is the range between topic-based and problem-based study. A topic-based course would focus on individual subjects while problem-based course would focus on the combination of several topics to create a solution. The pedagogy of these three distributed education courses is designed to focus on specific disciplines and create constructive, problem solving learning strategies. Figure Three describes this focus of learning.

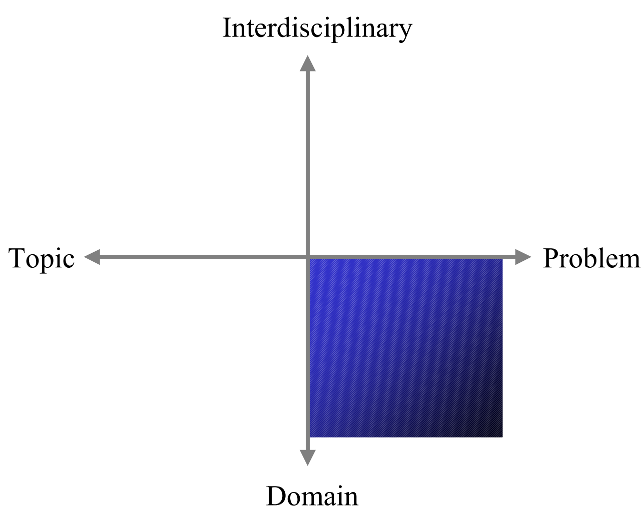


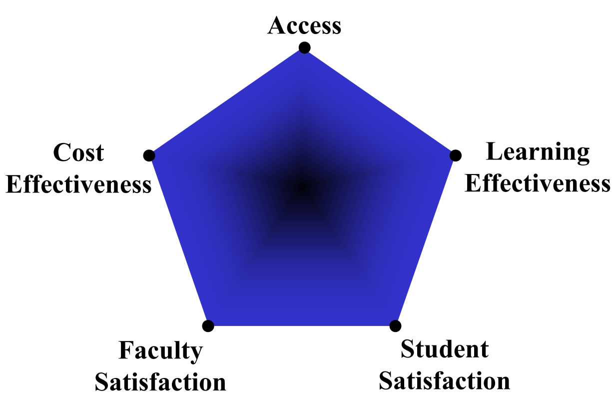
Figure Three: Focus of Learning
The Focus of Learning is measured along an axis created by Topic and Problem based learning and an axis of Domain and Interdisciplinary learning. The intent of these programs is to focus on constructive domain specific problem solving.

In summary, the objectives of these programs are to foster student learning through application and creation of knowledge, to create an environment where students take responsibility for their learning, and to concentrate the courses in a domain specific problem solving focus.

Design Principles

After the objectives of each course were defined with each instructor, the next step was to describe the design principles that would be used to accomplish the set goals. Factors considered in the design of the system include quality, interaction, group sizes, timing, and system optimization.

The foundation of this learning community and distributed education system design is the framework described by the Sloan Consortium for the creation of high quality education programs [17]. The Sloan framework is illustrated in Figure Four and defines five 'pillars' critical to quality; Access, Cost Effectiveness, Learning Effectiveness, Student Satisfaction, and Faculty Satisfaction. Access is the ability and ease to which a student can log in, retrieve content, contribute to a discussion, or to generally use the system. Cost Effectiveness is a ratio between value and investment, the goal to achieve the highest value for the most appropriate investment. Learning Effectiveness is the measure of the system's ability to transfer knowledge to the student and to demonstrate that the system is as effective as a traditional learning environment. Student satisfaction is the inclusion of support services, how well the system met expectations, and the student's opinion of the overall system. As alluded to in the theoretical framework, customer support and satisfaction must be an essential aspect of system design. Faculty Satisfaction is similar, but from the instructor's point of view of support services, expectations, and general performance of the system. All of these pillars are interdependent, a quality education system is a function of all five pillars.



<u>Figure Four: Sloan Pillars</u>
The Sloan Consortium defines five components, or pillars, required of high quality distributed education programs. The intent of this system design is to create a balance between all five aspects.

The design of the system's interactions is based on research from Woods and Baker [33] and Anderson [1]. This research defines three entities that interact with each other, the instructors, the students, and the content. Additionally, there are directions to these communications, e.g. from instructor to student and from student to content. Thus, these interactions and their associated directions can be described in a matrix. Using this matrix, the requirements of the system can be analyzed and described. For instance, the objective of student controlled learning will require high levels of communication, especially from student to student, with somewhat weaker interaction requirements between student to instructor and instructor to student. The content in these cases represent resources such as textbooks, instructor's web sites, and the learning management system. As such, there are lesser requirements for interaction between instructor and student to content, and little communication requirements in the opposite direction, from the content to the student and instructor. Figure Five portrays this matrix, including the shaded areas depicting areas of concentrated emphasis (e.g. student to student).

The Reigeluth and Moore model presents four groups sizes in its measurement scale, Individuals, the use of the tool by individual students, Pairs, the simultaneous use of the tool by two students, and Teams, the application use by three to six users. The description presented here modifies this theory to include two groups of users beyond teams. Small Groups is defined as seven to 24 students simultaneously using the tool, while Large Groups is defined as more than 25 students (corresponding to the maximum effective class sizes described earlier). This modification gives this model a more effective measurement resolution than the previous model and allows for the analysis of a larger range of diverse tools (see Figure Six). A simple graphing calculator would be an example of a tool for use by individuals, while a website or portal would be an example of an application for a large group of students. The intent of these courses are for students to work on assignments in groups, these groups are intended to be kept relatively small to ensure effective management and facilitation by the instructor. As a result the system should be designed for class sizes of about 12 to 16 individuals that can split into interactive groups sizes of about 3 to 4 students each, with provisions for both smaller and larger groups.

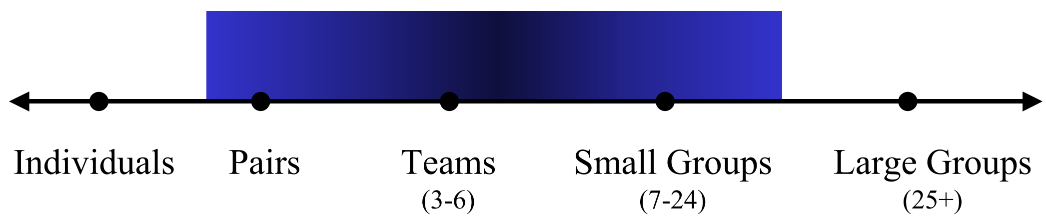


Figure Six: Ideal Group Size
These programs plan for weekly synchronous class size of 12-16 students capable of breaking into smaller teams and pairs for group projects or online discussions later during the week.

Another factor considered in this instructional system design was the consideration of timing. To accomplish the objectives of interactions and student focus, each course was intended to have a weekly three-hour seminar, but also individual and group activities throughout the week. The live seminar constitutes a synchronous component as does the group meetings, however some group work and individual work should be considered as asynchronous components. This is due to the fact that not all students will have access to the program and system at the same time as the instructor or even other students. As instructional designers consider the levels of student access, various tools can accommodate the time constraint better than others. Synchronous toolsets are designed to be used in real-time with other users while asynchronous tools can be used independently of time. An audio conference between a group of students or a telephone conversation between instructor and students would be examples of synchronous communication tools. A textbook or a field guide uploaded to a PDA, are examples of asynchronous tools that can be used independently from time or location. Figure Seven is used to illustrate the emphasis on both temporal aspects of the system.

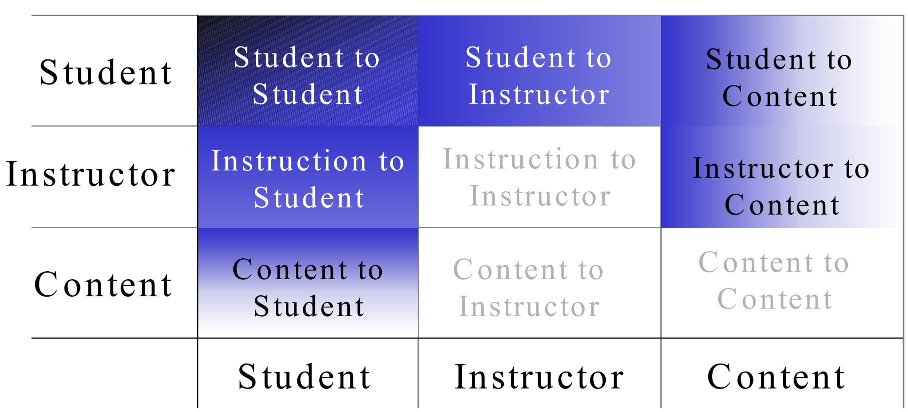


Figure Five: Interactions
This matrix illustrates three entities, students, instructors, and content. The main focus of this system is to emphasis the student-to-student interactions, with less emphasis on other interactions related to the instructor and content.

Figure Seven: Temporal Distance
These classes will have both asynchronous and synchronous aspects, for live weekly seminars and course assignments during the week.

The fifth design consideration is the system's optimization between efficiency, effectiveness, and attractiveness as described by Overbaugh [20]. These three considerations create a triangle to which optimal system design is a balance of all three. Efficiency as it related to this system design, is the ratio between quality and cost, the goal being to provide the highest quality for the lowest cost. Effectiveness is the measure of how much knowledge is being gained by the students and how successful the system transfers information or communication between instructors, students, and content. These two components have analogies to the Sloan pillars model with the inclusion of design or system attractiveness. Attractiveness is the visual, auditory, and other appealing features of the system, for instance a well designed web page, intelligent avatar applications, or an animated help menu. Attractiveness also speaks to how the system is able to motivate the student. The optimal system design is the creation of a cost efficient, easy to use and contains a useful toolset, and has well designed user interfaces with clear layouts. The design of this system concentrates on the efficient and effective aspects of the equation, with secondary emphasis on the attractiveness of the system, the darker shading in Figure Eight illustrated this emphasis.

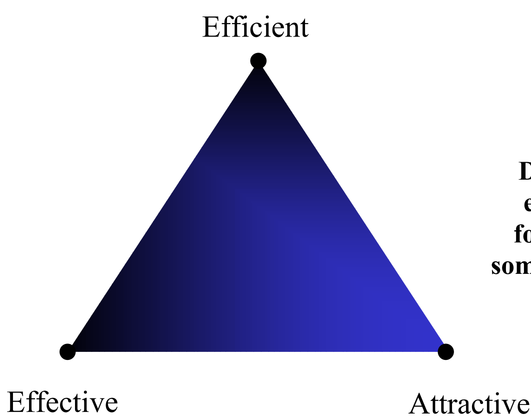
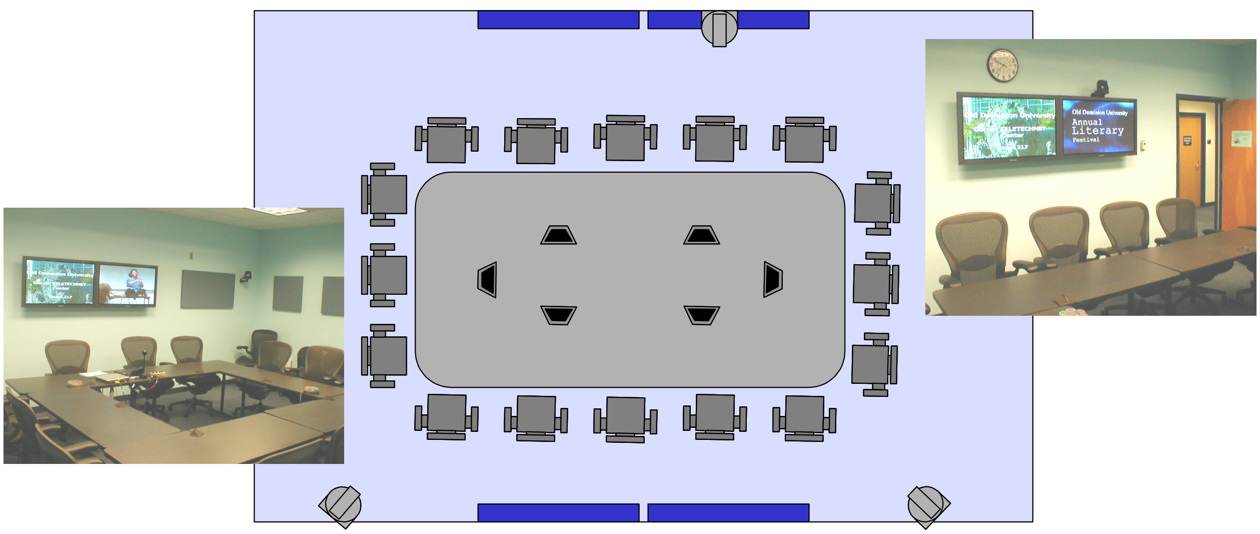


Figure Eight: System Optimization
Defined as a compromise between efficiency, effectiveness, and attractiveness, this design focuses on the efficient and effective axis with somewhat less emphasis on system attractiveness.

These five design models were applied to the program objectives described earlier to result in several design tasks. The Sloan pillars create a foundation for the creation of quality programs. The second consideration is to design the system to be able to easily accommodate student to student interactions, but to also allow for other interactions such as instructor to student and student to instructor, and to a lesser degree, interactions with the content. The third design task was to design for several groups of varying sizes including the 16 students in the synchronous environment (the 'classroom') and group projects of 2 to 4 students. The fourth design aspect is the consideration of time, meeting the pedagogical goals of these courses requires not only a synchronous weekly class and group meeting environments but also an asynchronous environment for collaboration and group work. The final system design consideration was the balance between efficiency, effectiveness, and attractiveness, with the goals of these courses more closely aligned towards effective and efficient operation. The next phase in the creation of this learning community is the actual implementation of the design.

System Design

System design for the delivery of these new courses starts in the classroom where the weekly synchronous seminar is held. The classroom is designed for local students as well as online webconferencing and videoconferencing students (see Figure Nine). The physical environment was designed around a central conference table to facilitate a better discussion flow between local students, this discourse is not possible in the traditional rows-of-desks layout. Additionally three cameras are located around the table such that anyone seated around the table is in a camera view. Twin plasma displays are located on both the front and the back of the classroom such that any two screens are viewable from any seat around the table. Located on the table are six microphones using an auto-gating audio mixer such that any student or the instructor can talk to each other or any of the off-site students without having to activate a push-to-talk system. The elimination of a traditional push-to-talk system also aids in simultaneous and immediate communication as students are not required to search for a button before talking. The instructor is provided a tablet PC running Microsoft Office 2003, thus the instructor can annotate PowerPoint slides and save those annotated files for posting online. The instructor also has a wireless Crestron panel for control of the classroom's video and audio sources. Program audio and video from the classroom is routed to a conferencing codec to connect to other videoconferencing students and to a web streaming codec to stream video to and from online Internet students. The system is configured such that any student can see and interact with any other student regardless of the connection and delivery methodology.



<u>Figure Nine: Classroom Environment Design</u>
The classroom provides an effective origination environment through the use of space saving displays, multiple camera angles, automatically gated microphones, and seminar styled seating.

The distributed learning system is created using video and webconferencing technologies and online collaboration tools. Videoconferencing students register and attend class at a local institution and attend the weekly seminar in a 2-way videoconferencing classroom that is connected to other classrooms via ISDN, ATM, or IP protocols (H.320, H.321, & H.323 formats). Online students, whom could not attend at campus or any of the remote videoconferencing locations, use a webcam, headset, and a high speed Internet connection (DSL or cable). Internet students connect to a webconferencing server such as Macromedia's Flash Communication Server or First Virtual Communication's Click2Meet server. Students over the Internet can see and interact with the instructor and other students through the web conference connection to the classroom. The main campus classroom architecture serves as a bridge between the local, videoconferencing, and webconferencing students during the weekly seminar meetings.

During the week students in each class are broken into small groups where each individual student is able talk to each other and to the instructor. This is accomplished through the use of several tools. Synchronous communication tools include Instant Messaging for short messages and dialog, and webconferencing for longer duration presentations and discussions with audio and video. Email for in-depth analysis, critiques, and simple file transfers, and discussion boards for thought presentation and debate, are used for asynchronous communication. Content from either the instructor or the students are posted to a website, and links to an on-demand video archive of every weekly seminar meeting is provided to review missed classes.

Conclusion

Faculty at Old Dominion University sought to extend the current distributed education system into areas not traditionally served, this area specifically included graduate seminar programs. Research in the available literature showed that the success of a Ph.D. level program is dependent on a learning community. This learning community provides a venue for students to share ideas, critique each other, interact with instructors, and gain knowledge that would not be available in a classroom environment. This review also reinforced the importance of distance education and the growing demand for more programs. Additionally, the learning community created by residential doctoral curriculum could be replicated by comprehensive instructional design and the appropriate application of technology. The design process employed here consisted of dialog with the instructors of three proposes classes, one Instructions Design and Technology and two Modeling and Simulation courses. The research also shows that engineering, technology, and applied science courses such as these generally present similar design challenges as other curriculums and programs. Thus proven results from other studies should be applicable to this scenario.

The design process used three phases to reach a solution. The first phase included discussions with the instructors to ascertain their expectations and goals. The objectives explored could be described in terms of the appropriate Learning Style, the Control of Learning, and the Focus of Learning. The second phase was the comparison of these objectives to design considerations such as quality, participant interaction, group size, temporal planning, and practical constraints. These five models are described graphically to provide a means to illustrate the design to the instructors to ensure communication and expectation throughout the process. The third phase was the selection of the tools and methodologies used to meet these program objectives. The result is a new classroom environment that fosters a distributed learning community between local and distance students through the use of synchronous conferencing and asynchronous collaboration technologies.

The system has been in use since August 2004 with feedback collected from the instructors and the students at the end of this first semester. Early review of the surveys show an increased level of faculty and student satisfaction as well as an overall subjective impression of increased learning effectiveness due to both synchronous and asynchronous communication methods. Further work is required in this area to better determine the validity and reliability of this design. The next phases of this new approach to learning community design will be the assessment of the system to determine how well it meets the expectations of students, expectations of faculty, fosters learning effectiveness, and to determine the directions to improve and evolve the design. Another future evaluation of the system will be to determine how well it facilitates the research aspect of a doctoral program not just coursework and community building.

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