MLS Student Active Learning within a "Cloud" Technology Program

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ABSTRACT

In November 2009, the MLS program in a large public university serving a geographically large, sparsely populated state instituted an initiative for the integration of technology enhanced teaching and learning within the curriculum. This paper is intended to provide an introduction to the system requirements and sample instructional exercises used to create an active learning technology-based classroom. Discussion includes the following: 1.) define active learning and the essential components, 2.) summarize teaching methods, technology and exercises utilized within a "cloud" technology program, 3.) describe a "cloud" enhanced classroom and programming 4.) identify active learning tools and exercises that can be implemented into laboratory science programs, and 5.) describe the evaluation and assessment of curriculum changes and student outcomes. The integration of technology in the MLS program is a continual process and is intended to provide student-driven active learning experiences.

ABBREVIATIONS: MLS-Medical Laboratory Science

INDEX TERMS: Active learning, cloud technology, problem-based learning

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INTRODUCTION

University classroom education has historically focused on conveying a series of facts and cognitive information to students.[1,2,3] All educational levels, including higher education have perceived education as a process for transmitting information from teacher to student.[1,2] This information is organized, limited and often specific to a very narrow spectrum of information. The process is limited by the amount and type of information presented by the teacher. This delivery method fails to engage the students in a manner that provides the student with the opportunity to synthesize and incorporate the information as learned or permanent knowledge.[1,4] The educational process limits the student's ability to make mistakes, recover from them, deconstruct what went wrong, and start over again.[1] The traditional practice of instructor-directed information transmission and dissemination requires professional educators to refocus and re-engineer the classroom pedagogy in order to effectively utilize the active learning cloud classroom outlined in this paper. Previous studies clearly indicate that the integration of active learning within the classroom strengthens the student's acquisition of knowledge and provides students the opportunity to organize and apply information.[1,2] This is particularly important in University based MLS programs facing a decrease in clinical training sites. Implementation of active learning in the classroom requires defining active learning, summarizing teaching methods, technology and exercises, describing "cloud" enhanced classroom, identifying active learning tools and exercises and describing evaluation and assessment of changes towards active learning.

Active Learning

Active learning is the process of engaging students in activities requiring the students to organize, make mistakes, deconstruct what went wrong, and start over again.[1,2,3] Active learning provides students with the opportunity to clarify, question and apply the

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information by consolidating the basic terms and concepts as well as integrating the information into their fundamental experiences and memory.[1] Exercises considered to be active learning include discussions, analyzing, synthesizing, problem solving, case studies, role playing, journal writing and structured learning groups.[3,4,5] This pedagogical approach is directed at reaching the current generation of college-age students who have been referred to as primarily active learners.[6] Numerous studies have indicated that active learning strategies improve the retention of content, improve student attitudes and achievement, and improve writing and critical thinking skills.[1,3,4,6,7] With implementation of active learning exercises, the instructor must give up the need to summarize and transmit cognitive material to the student.

In order to optimize the effectiveness of the alteration in pedagogy for a specific subject area or concept the instructor must consider the student frames of reference and skill sets. These can be grouped into 1.) constructivism, 2.) social constructivism, 3.) zone of proximal development and 4.) metacognition. Constructivism is the act of constructing new knowledge and understanding from within the student's current frame of reference and existing knowledge.[3,4,8] In other words, instructors must determine students' existing knowledge and compare it with what the students need to begin an activity. Secondly, social constructivism examines how the students construct new knowledge within the current social influence.[8] In consideration of the students' previous knowledge and social context for the activity, the instructor must also understand the group's zone of proximal development. The zone of proximal development is the determined distance between actual knowledge and the potential for the development of new knowledge.[8] This can be measured by initial screening, pre-tests or previous activities within the classroom and relies on the interaction between individuals with different levels of knowledge related to the proposed learning activity. This information can then be used to pair a weak student with a stronger student thereby improving the learning environment.[3,4] Finally individual students must have some understanding of their independent level of metacognition, or self-awareness of their skills and problem-solving ability.[8,9] Students should understand how they would approach a problem, evaluate the approach and change their approach to the problem differently in the future. Students must be engaged and focus not only on content or cognitive knowledge but the process to successfully improve their learning skill sets.

Once the instructor has a clear understanding of the student's frame of reference, knowledge and skill sets, the instructor must determine the logistics of the activity. The instructor must consider when the exercise should occur during the class, how much time the activity will consume, whether the activity is graded, what the follow-up process will be and how to assess the effectiveness of the activity.[3,4] The process of effective planning and implementation of active learning exercises for the classroom is essential. Exercises and activities included within the course content should clearly demonstrate added value to the course and should not be included simply as a means to use the technology.

Active learning is not new to MLS educators. MLS has historically included lecture based classroom instruction paired with active learning within laboratory classes and a clinical practice or internship during the educational process. This model is currently being challenged by a decrease in clinical training sites subsequently reducing the students' opportunity for the development of complex skills used within an actual laboratory setting. These skills include evaluating workflow, interpreting complex slides in real-time in comparison to printed instrument data, and developing technical skills such as steps used while performing a test. This requires the incorporation of new teaching strategies within MLS education to meet the changing needs and education of new professionals.

Technology in Education

MLS is a technology-based allied-health degree, and a technology based program provides laboratory exercises and classroom experiences which include the regular use of advanced applications through the incorporation of technology based education. The traditional educational methods included in laboratory science span three types of pedagogical models: 1.) Traditional face to face instruction within the classroom, laboratory and clinical training; 2.) web enhanced, up to 29% of the content delivered on-line through a course delivery system such as Blackboard, Web-CT, Desire to Learn (D2L), or E-college and 3.) fully on-line course, 100% of the

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classroom material is delivered on-line.[2] All three models require a clinical practice or internship. A new focus and re-engineering of instructional pedagogy has emerged from the three forms of educational models described. This new model is entitled the blended or hybrid method and requires that 20-80% of the program material be presented on-line and utilizes discussions and technology based active learning strategies in addition to the use of a course management system used in web-enhanced instruction. Additional active learning strategies in the blended or hybrid model includes widgets, drop box, group lockers, animations, video streaming and interactive software components.[4] The remaining course material is presented face to face with the instructor. In conjunction with higher education, laboratory science programs have began to increase the incorporation of active learning and technology during the face to face classroom instruction.

"Cloud" Enhanced Classroom and Programming

In December 2009, the Medical Laboratory Science Program began planning for the implementation and assessment of the effectiveness of an active learning technology "Cloud" teaching and learning environment. The enhanced cloud environment includes the addition of equipment, software and a specially designed classroom. Changes to the instructional methods within the MLS program include alterations in instructional design, purchasing equipment and software, as well as attending workshops in order to understand and transition into a "Cloud" program.

So what is the cloud? The term cloud technology encompasses the use of advanced technology in computing through the use of visual and audio equipment, specialized software and virtualization. This includes expanding the use of available web 2.0 learning tools, and virtualization of lectures in the classroom and laboratory independent of location and the type of technology equipment.[2] The increase in technology based material is coupled with a decrease in lecture and content driven instructor based activities to a nearly 100% student-directed learning environment.

In order to utilize advanced technological applications used in the Medical Laboratory Science program, the students are required to furnish a laptop that meets specifications recommended by the university information technology staff. In addition, the traditional classroom was redesigned including the installation of enhanced computer technology. The classroom technology includes a dual projection system (two overhead projectors), a traditional movie screen, an interactive "Smart" board, an Elmo, a digital video imaging microscope, additional video equipment (DVD player, AVI, audio system), six hard-wire student internet connections, a wireless network, a complex control module, a desk top computer and wiring to accommodate a secondary computer. The required detailed technical components and estimated cost are outlined in Table 1. In addition, the classroom was furnished with 18 inch wide electrically wired tables in order to accommodate student course materials and lap tops.

Table 1. Equipment and Cost Analysis for a Technology Enhanced Interactive Learning Environment Classroom.

EQUIPMENT	COST
AVS-PR-1204-567 AMX matrix switcher	$2650
NI 2100 Netlinx controller	$950
AMX NXD-500I	$1250
AMX PSN4.4 power supply	$80
AMX AC-RK accessory rack mounts	$44
2 projectors (Sharp XG-435X w/mount)	$3600
2 screens (Da-Lite model C 100" matte)	$430
Elmo HV 5100XG document camera	$1800
Panasonic DVD/VHS combo unit	$250
Kramer VP-111 vga amplifier	$65
Pair of JBL Control 5 speakers and mounts	$440
Crown D-75A audio amplifier	$423
RDL line mixer ST-MX3/PS24A/L2/6 lite	$156
Podium /cabinet/shelf/ctrl panel/misc.	$3271
Computer	$1200
Smart Board	$1450
TOTAL	$18,059**

** Total may vary dependent on University contracts, location, or Vendor substitutions in equipment.

The design of the classroom provides the faculty with the tools needed to project two independent images simultaneously from two computers. The projection capabilities include the transmission of information from the main classroom computer and the faculty laptop or a student laptop positioned at one of the hard wired network connections strategically placed throughout the room. A software program is now available that will permit the projection from any computer in the classroom and link to the projection system in the absence of a hardwire connection.

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Currently, the classroom is limited to projecting from a student's laptop that is hardwired to one of the network connections.

Technology Based Active Learning Exercises

Implementation of enhanced technology within the MLS program provides the opportunity for the incorporation of active learning exercises using a variety of programs, software and web based activities. Such exercises allow students to develop cognitive skills through application and review, as well as providing immediate feedback and re-evaluation of the material included in the lesson. Students are able to solidify concepts and share and explore alternative options through these processes in a comfortable learning environment.

The resources incorporated within the MLS program represent three general types of activities including collaborative, interactive and assessment.[4,12] Collaborative exercises allow students to work simultaneously with other students and/or the instructor to analyze a problem, look at alternative responses and ultimately reach a common conclusion or compilation of data. Collaborative exercises implemented within the MLS program include: real time interactive case studies within the learning management system and advanced organization of student-directed projects visible to all students within the classroom from a student computer connected remotely. Student-directed projects may include writing and editing educational objectives, reviewing laboratory data sets and writing a procedure or position paper. On the surface, such exercises appear to be traditional tools for use within the classroom as instructor-directed or a small group activity where the instructor provides a written set of data and instructions. However, when the activity is used in an enhanced technology classroom the interactions become more dynamic. For instance the incorporation of a case study takes on a simulated laboratory appearance either through a course management system or virtualized laboratory information system. Course management systems allow instructors to link information access to student responses. In other words, students access a specific piece of data and are required to submit a response before the next piece of data or information is released. The entire process occurs independently of the instructor and can be individualized for each student. Secondly, lab information systems can now be networked electronically without the need to load software onto each student's independent computer with wireless classroom and laboratory access. Through each of these delivery methods, students receive the patient's history including signs and symptoms via computer access in a format similar to or in an actual virtual laboratory information system. Students are able to electronically submit laboratory test requisitions. Following submission of the test request, students are provided with electronic lab results entered by the instructor through the course management system or virtualized laboratory information system. The process continues over a period of days, allowing the student to observe how the patient's results evolve over time. The instructor has the opportunity to personalize and alter results for the students based on the "real time" electronic interaction. This process increases the students' incorporation of critical thinking and integration of knowledge across the disciplines within the MLS curriculum.

Active collaborative computer based technologies may be implemented in the classroom in three formats; "Smart" board activity, student to class computer projection, or small group to class computer projection. The initial step in changing the instructional pedagogy may include technology based active learning tools which do not require "cloud" technology. An example of this is the use of the previously described collaborative exercise by projection to the entire class via the smart board. The smart board provides the opportunity to consolidate a document which can be modified in real time. Document modification includes computer alteration by highlighting, overlaying of written material or the addition of computer graphics. The final product or stepwise versions of the activity may be electronically saved and accessible for students to review at a later date. The classroom projects and exercises previously described in this section can also be moved to a "cloud" application or delivery method.

The addition of the "cloud" technology to a collaborative exercise extends the exercise beyond a single activity permitting an individual to alter the document independently to the simultaneous alteration by the entire group of students seated throughout the classroom. "Etherpad" is an example of a cloud based program that allows students and/or instructors to alter

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and develop an exercise or document in the cloud. In addition to Etherpad, there are several other versions of similar programming available. Some examples are included in Table 2. These programs allow students to type directly from the student laptop to the document as it is displayed to the class. Students are identifiable by a color coded program. This allows the instructor and students to track progress and save sequential versions of the document. The University instructional design staff has also created a web-based, password protected system for students to modify documents and group projects within a virtual server.

Collaboration and sharing may also be accomplished outside of the classroom through the utilization of a web-based electronic portfolio, referred to as an e-folio. E-folios are electronic sites published on the web. When utilizing an e-folio internet site, it is important to consider the safety and security of student information. "Weebly.com", is an electronic portfolio site with an educational version that allows the instructor to create password protected student accounts. E-folios provide students an opportunity to showcase their capstone projects, research and resumes for sharing with other students, potential employers and colleagues.

In addition to technology based collaborative activities, students are also engaged independently with interactive programming. Interactive technology exercises allow students to work within the "cloud" in a limited environment confined to the MLS program or in an extended environment with other programs or institutions. The MLS Program has utilized several interactive resources to provide students with foundational content as well as enhance the understanding of an advanced technique or concept. Extended or public domain internet based activities include interactive games (www.nobelprize.org/educational), an animated PCR laboratory (http://learn.genetics.utah.edu/content/labs/pcr/), Itunes University, molecular design of PCR assays (Invitrogen) and animated videos (Howard Hughes Institute). If there are no current resources available as a teaching resource for a specific concept or technique, learning modules can be created using a Flip camera and Camtasia software. This software provides the instructor with the flexibility to incorporate video, voice over and physical movement of an interactive activity and record the entire process for student review. Interactive virtual laboratories allow students to manipulate instruments enhancing understanding of testing procedures, troubleshooting and results.

Finally, in addition to instant feedback and assessment of exams, quizzes and assignments, real time response software may be included in lecture and peer review exercises. Peer review of student papers can be completed using Turnitin. TurnItIn is a program that allows students to submit papers, have them peer reviewed and provide the instructor the ability to provide feedback and examine the paper for plagiarism. In addition, many Universities and other educational institutions have implemented the "Clicker" technology allowing the instructor to test or poll students in the classroom and obtain real time data. Clicker technology is available for use in any classroom with the purchase of battery operated clickers for each student and a receiver. However, the cost may be minimized by purchasing an adaptable laptop software program without the additional purchase of receivers or clickers. These exercises can be included in a course as a graded

Table 2. Technology Resources

Name	Website: Company	Description
Smart Board	http://smarttech.com	Equipment and software
Desire 2 Learn (D2L)	www.Desire2learn.com	Learning Management System
Etherpad	http://ietherpad.com/	Collaborative writing tool
Titanpad	http://titanpad.com/	Collaborative writing tool
Typewithme	http://typewith.me/	Collaborative writing tool
Howard Hughes Medical Institute	http://HHMI.org/biointeractive/video/	Animation videos, virtual reality laboratories
TurnItIn	http://turnitin.com/	Document peer review; plagiarism, instructor review
Turning Technologies	www.turningtechnologies.com	Clickers, Polling and data collection system
Camtasia	http://www.techsmith.com/camtasia/	Video editing, voice over, power points or video
Flip Video	http://www.theflip.com	Video software
Weebly	http://weebly.com	e-folio

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or a non-graded item, and allow for immediate feedback and assessment of the students.

Assessment and Program Evaluation

Activities may be integrated into a course as graded or non-graded items. Traditional assessment methods, including exams, quizzes, papers and laboratory reports may still be used in the active learning environment. However, when utilizing an electronically based learning activity additional assessment criteria should be included when the activity requires student to student collaborations, faculty to student interactions or student review or participation. Evaluation must include outcomes that measure student engagement and participation in electronic active-learning exercises. These items include measurements of individual contribution and collaborative behavior. Each individual should expect quantitative (amount of time or number of responses) and qualitative (quality and content) external evaluation of their engagement and participation by the instructor and peers. This type of assessment incorporates a combination of both the students' individual and entire group assessment to calculate each student's final score related to the activity.[13]

In addition to modification in methods for student assessment, evaluation of the change in the MLS program pedagogical delivery is essential to maintaining a quality program and for the continued improvement of student learning outcomes. The MLS program has therefore expanded the current program evaluation. In addition to exam scores, clinical faculty evaluations, employer evaluations, Board of Registry Scores and student personal reflections the program has added a technology and community of learning survey, identified benchmark exam questions and instituted a student learning style survey. The formative evaluations will be coupled with existing summative information such as grade point average, ACT scores, comprehensive final, certification exam and University Proficiency exams integrated into a meta-analysis to evaluate the effectiveness of the pedagogical changes on student outcomes. This information is intended for publication and dissemination at a later date.

CONCLUSION

The movement from a traditional laboratory and classroom program to a technology enhanced "cloud" curriculum is a learning process for both faculty and students. This process must be gradual and purposeful and is designed to decrease the required time commitment for clinical practice following classroom instruction. Programs and instructors should consider the value of the activity in comparison to the expected outcomes. In addition to cost, faculty will be faced with challenges and new opportunities as access to technology and new software increases. When implementing technology enhanced activities in the classroom it is essential to set the stage for students. Information regarding the expectations as well as software or specialized equipment such as laptop requirements must be available within the program description and course syllabi. The new classroom exercises must demonstrate value and have a clear purpose with measurable outcomes. Individual instructors and/or program policy should provide grading policies, accommodations for non-participating students as well as proper evaluation of learning outcomes.[4,12] Students may not immediately appreciate the time, effort and outcome measures associated with active learning activities. However, they will understand the immediacy and appreciate the ability to debrief, respond, provide feedback, make observations and see results in real time. Employers and educators will be required to evaluate and improve the non-hospital/clinical based instructional environment as it relates to professional performance and skill sets required to enter the laboratory. Change is difficult but as Richard N. Katz stated; "As we slide farther and farther down the rabbit hole, we stare at or interact in wonder with grids, semantic webs, wikis, podcasts, open education resources, social networks, and other destinations..."[2] So take a trip into the technological wonderland. Increased student success may simply be a click away.

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