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A Learning Theory Conceptual Foundation for Using Capture Technology in Teaching

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Abstract

Lecture capture technologies are increasingly being used by instructors, programs, and institutions to deliver online lectures and courses. This lecture capture movement is important as it increases access to education opportunities that were not possible before, it can improve efficiency, and it can increase student engagement. However, this is just the start for how capture technology can be used as it only considers an objectivist learning theory approach in deployment. As a result, it is essentially a modern version of "sage on the stage" where an expert projects information for consumption by students. Capture technologies, though, hold promise to go beyond this basic implementation as they can fit into the constructivist learning paradigm too, which requires students to take what they have learned and apply it to new concerns of importance to them. In addition, capture technology can be used to develop learning support resources, known as scaffolds, and be used to improve assignment integrity and assurance of learning. Ideas for how capture technology can be used to address these important learning concerns are presented and discussed.

Keywords: Lecture Capture, Learning Theories, Objectivist Learning, Constructivist Learning, Scaffolding, Assurance of Learning, Instructional Design

1. INTRODUCTION

The promise of the internet and technology-mediated teaching to revolutionize education has been hyped for more than a decade but until now the ability of technology to fundamentally alter teaching and learning has largely gone unfulfilled (Wiley, 2000). This time, though, may well be different. Online courses and programs are seeing large enrollment gains while new entrants like the Khan Academy or Coursera, Udacity, and EdX, known as MOOCs (Massively Open Online Courses), are challenging traditional education institutions and instructors (Youngberg, 2012; Deneen, 2013).

Recorded lectures are a key feature of these new educational structures (Kay, Reimann, Diebold, and Kummerfeld, 2013) and the lecture capture technology used is seeing "acceptance rates that are remarkably positive" (Greenberg and Nilssen, 2009). Lecture capture systems are fast evolving with capabilities that exceed simple recording of video to capturing a host of media and inputs, and as such, will often be referred to more generally as capture technology.

For the most part, the focus on using capture technologies in education has been where an expert records something for viewing by students. While this is an important application, it is effectively just a modern version of the "sage on the stage", or in learning theory terms, it is *objectivist learning*, where students are expected to remember and repeat what has been presented to them.

Capture technology has potential to go beyond passive, objectivist learning to enable active student participation and content creation. Assignments and courses can be designed to encourage *constructivist learning* where students are challenged to extend what they are being taught to solve new problems of interest and importance to them. Traditionally this might be accomplished by having students discuss in class or write about why and how what they are learning can be applied in their lives; and these are still important. But with capture technologies, the opportunities are expanded, with additional benefits possible as well. For example, capture technology can be used to enhance assignment integrity and assist in assurance of learning efforts too as students record themselves completing assignments.

Designing assignments and courses using capture technologies in concert with learning theory and concerns, not only makes good academic sense, it has practical value too. A survey of employers conducted by Hart Research Associates (2013) for The Association of American Colleges and Universities, shows employers strongly support a blended model of liberal and applied learning. Nearly 93 percent of employers agree "a candidate's demonstrated capacity to think critically, communicate clearly, and solve complex problems is more important than their undergraduate major" (Hart Research Associates, 2013, p. 1). In addition, "more than four in five employers say an electronic portfolio would be useful to them in ensuring that job applicants have the knowledge and skills they need to succeed in their company or organization" (Hart Research Associates, 2013, p. 3).

Given the promise of lecture capture, this paper considers a learning theory approach to how capture technologies can be used in teaching that has been missing from the literature to date. In this effort, an emphasis is made to illustrate how capture technologies can be applied in practice as a means to facilitate adoption by others.

The remainder of the paper is organized as follows. Section two overviews the current use of lecture capture in the literature. Then, a review of learning theories and concerns is presented. This includes objectivist learning, constructivist learning, social constructivism, assurance of learning and ensuring assignment integrity. Section three presents ways in which capture technology can be utilized to meet the tenets of these learning theory and concerns.

2. LITERATURE REVIEW

Lecture Capture

The use of lecture capture systems in higher education has been an active area of research with many dozens of articles in the literature. The vast majority of these works focus on how instructor-generated material is received by students and how it impacts their learning experience in terms of satisfaction, performance, attendance for in-person meetings, and video usage. Interested readers are directed to works by Pursel and Fang (2012), Owston, Lupshenyuk, and Wideman (2011), and Green, Pinder-Grover, and Millunchick (2012) for useful reviews and reference lists. Generally, the research finds that students use and appreciate the availability of videos, believe it helps their performance, and the availability of videos does not reduce student attendance. These works, however, concentrate at the lower levels of learning taxonomy and on an objectivist learning approach.

The use of student-generated lecture capture in higher education is much less pervasive even though it holds promise for higher-level, constructivist learning. At the university level, student-generated capture approaches appear focused on recording student oral presentations and in teacher education programs.

Smith and Sodano (2011) investigate the use of lecture capture for increasing presentation skills through self-assessment and review of recorded speeches. Tazijan, Rahim, Halim, Abdullah, Ismail, and Cochrane (2012), meanwhile, show positive impact from using lecture capture technology to improve presentations in English as a Second Language (ESL) students.

In teacher education, Otrel-Cass, Khoo, and Cowie (2012), investigate how to use videos for learner support, known as scaffolding, by science teachers. Forbes (2011), meanwhile, reports positive results with using student-generated podcasts for reflecting on learning. Shafer (2010) utilizes student-generated screencasts for teaching mathematical proofs to education majors. The students recorded themselves presenting a proof, which were reviewed and critiqued by the instructor and then used in class for peer review and critique. This work by Shafer (2010) is significant in that it explicitly considers learning theory, Bloom's taxonomy, in deploying capture technology.

Learning Theory and Concerns

Bloom's Taxonomy of Learning

Bloom's taxonomy of learning, first proposed in 1956, identifies a learning hierarchy of lower and higher order concerns (Bloom & Krathwohl, 1956). Updated by Anderson and Krathwohl (2001), the lower levels of the hierarchy include remembering and understanding while higher order concerns included analyzing, evaluating, and creating. With student-generated capture assignments and approaches, high-order learning can be targeted. Most lecture capture applications in the published literature, though, are essentially just electronic lectures that address the lower levels of this hierarchy. Moreover, using capture technology in this manner aligns with objectivist learning theory.

Objectivist Learning

Objectivism theorizes that knowledge is an externality and thus independent of learners. As Hannafin, Hannafin, Land & Oliver (1997) reaffirm, learners learn by "decoding the established meaning of various objects and events […], provided by the learning systems designer" (p. 108). As such, objectivism is sometimes viewed as "regurgitation," with students expected to "expel" what has been ingrained in them by the expert. Furthermore, the onus of learning is viewed as falling on the instructor, and if students do not recall effectively, the instructor must adapt means and measures of learning so that students can do so the next time (Cronjé, 2006; Jonassen, Collins, Campbell & Bannan Haag, 1995). This is what many lecture capture implementations try to do. A student watches a lecture, then takes a quiz for understanding. If the student fails, they may be guided to repeat the lecture or brought to a different video lecture on the topic, and then retested.

This is not to say that objectivist learning approaches and lower order learning concerns are trivial, because they are important and they have their place. It is, however, more a factor of missed opportunities for capture technology teaching approaches where the full potential to enable high-level and constructivist learning are not considered much less achieved.

Constructivist Learning

The basic premise of constructivist theories is that humans "construct" their own understanding, and ultimately their knowledge, of the world around them via a process of active experimentation (Chickering & Gamson, 1991; Kolb & Kolb, 2005; Knowles, 1988). When reflecting thereupon, they either alter their current understanding or transformatively construct anew (Mezirow, 1997).

In a constructivist paradigm, one thing is clear, students must be active participants in their education experience. Otherwise, their constructed learning, and indeed their overall constructed knowledge, will be diminished and affect their continued development as they move through their academic program. Therefore, the "test" of whether learning has taken place in constructivist paradigms is the response and performance of students as they progress through the educational ranks: can they solve appropriate, new problems using what they have acquired through their studies to that point.

The constructivist approach to learning also changes the role of the instructor. Rather than merely being a "sage on the stage" the instructor is charged with developing a conducive learning environment with meaningful learning experiences and structures. In the words of Meyers and Nulty (2009), "'High quality' learning outcomes should result from the interplay between students' learning efforts, the curricula and the teaching methods used" (p. 566). In such a conducive learning environment, constructivism accommodates and promotes a variety of teaching approaches that invariably encourage students to actively experiment—to breakout of the sterility of the classroom and into the world of work—to facilitate true reflection on their observations, and to do so either individually or in collaboration with others.

Social Constructivism

Social constructivism extends the constructivist approach to include the ability to work well with others to accomplish a goal. Following social constructivism, it is incumbent upon instructors and those responsible for the development of academic programs to cultivate such abilities in students. Vygotsky (1978) posits that the collaborative aspect of learning is important to constructivism believing that knowledge is incrementally constructed via social or cultural interaction, termed 'social constructivism.' In practical application, this is often seen through group or team projects and presentations, class discussions and debates, or through service learning and experiential assignments and courses.

Scaffolding Learner Support

Using constructivist theory, facilitative teachers are able to appreciate where students "start" and then guide them through these new experiences, enabling students themselves to build new understanding and, with further experimentation, competency. An important aspect of this support is scaffolding, which is the development of a support structure to facilitate learning. Scaffolding is a process through which the instructor (or a more competent peer) provides guidance and support to the learner, and then systematically tapers it off as the learner becomes more capable (Balaban, 1995).

Capture technologies can be used to develop student support materials, scaffolds, with content accessible to students even when an instructor is not present to help. Students can then access remedial content or revisit a topic, through a learning management system such as Blackboard or Moodle as they desire, giving the student control in their learning. For example, remedial content focused on ensuring students have the technical knowledge and skills needed to not only begin a course but to succeed in it can be made available before the course actually begins.

While it is clear that capture technologies can play an important part in both traditional and online courses, it will take thought and effort to deploy them in a manner that adds value beyond simply increasing access and efficiency. Ellis & Goodyear (2010) state that "[t]eachers who focus on the development of student understanding and have richer conceptions of learning technologies, not only integrate e-learning into their approach to teaching, but also stress the importance of the integration of learning across physical and virtual spaces" (p. 104). Often, though, this is not seen to be the case. Thorpe (2002) claimed that "[t]raditionally, learner support is seen as that which happens after the course materials have been made" (p. 106), or as Lee, Srinivasan, Trail, Lewis and Lopez (2011) framed it "as an add-on to pre-designed courses, but it has since been recognized that it should be considered and integrated into course design" (p. 158).

Assurance of Learning and Assignment Integrity

Regardless of the theoretical approach used, the technology employed, or whether the work is performed alone by students or in collaboration, it is fair to say that educators and employers alike are interested to assure that learning has occurred. In constructivism, learning is often prized as a unique experience, even during group or team-based projects, and therefore one that has individual results and traditionally this is hard to measure (Arum & Roksa, 2012).

Capture technologies not only enable a new approach to individualized learning during collaborative efforts but facilitate a personalized documentation and performance history as well, thereby aiding the measurement of learning. As students incrementally develop their capabilities, and these are captured, this evidence can not only be viewed and evaluated by the instructor but students can share this evidence with both current and/or prospective employers and others as they decide. Throughout the entire program, student learning can be documented so every course has something to contribute to the student learning portfolio. Capture technologies can facilitate truly modern e-portfolios, which employers value in accessing candidates for hire (Hart Research Associates, 2013).

Ensuring that students actually complete assignments themselves, and within the rules set forth by the instructor, is an important component of learning efficacy. It has been found that most college students admit to some form of cheating (McCabe & Trevino, 1993) with business students being more likely to do so than other majors (McCabe, Butterfield, & Trevino, 2006). While cheating appears to be more prevalent in online courses, a survey by Lanier (2006) reassuringly found rates lower

than previous studies. LoSchiavo and Shatz (2011), on the other hand, found most students cheated on at least one online quiz and honor codes appeared to have no impact on cheating by fully online, asynchronous students. Some institutions have begun to address the issue of cheating on outside exams by employing e-proctoring services like ProctorU (www.proctoru.com) that use webcams and a verification process to increase exam integrity. Similarly, lecture capture technology can be used to record exam completion as a means to discourage cheating.

Pedagogically, then, capture technology underscores and neatly aligns with extant learning theory. Capture-based approaches can improve student engagement with the material and increase instructor efficiency. Furthermore, it can play a role in achieving not only objectivist learning but aligns well with constructivist and social constructivist learning too. By engaging students in the creation process, high-level, deep learning can be achieved, documented, and made available for use, as desired.

3. LECTURE CAPTURE APPLICATIONS

This section presents ideas on how capture technologies can be employed in concert with the aforementioned learning theories. The applications vary in focus and intent, have relevance to a wide range of courses, and effort is made to show how others can use these approaches in their courses. First, though, a short discussion of the lecture capture programs used by the authors is presented.

The lecture capture applications that follow can all be accomplished using readily available programs. The authors are currently using three different lecture capture programs: TechSmith Jing, Adobe Captivate, and Panopto. Jing, is a free, basic screen capture and recorder program. It is useful for student-generated content but is limited to five-minute videos with no editing capabilities. Adobe Captivate is a full-featured capture and editing system that can be purchased standalone or as part of Adobe's eLearning Suite. Captivate is a powerful program, with commensurate complexity, that can be used individually or as an organization-wide system and is particularly useful for instructor-generated content. Panopto, meanwhile, is an institutional-level system that can be used to create individual videos or video repositories by students, instructors, and institutions alike.

Pre-Recorded Lecture Videos

As noted earlier, pre-recorded lecture videos are a common use of capture technologies spanning from the Khan Academy and MOOCs to individual instructors developing videos for their courses. Pre-recorded lectures—especially when coupled with assessment capabilities—provides an efficient and scalable means to reach students and to achieve the low-level learning objectives of remembering and understanding in an objectivist manner. Using capture technology in this way is ubiquitous and important because it applies to virtually any subject or course where basic or foundation material must be communicated, repeatedly.

Pre-Recorded Solution Videos

Developing pre-recorded solution videos is a way to use capture technology for teaching complex problem-solving activities, especially quantitative, computer-based problems. In its most basic form, this application is still primarily an objectivist approach that addresses the lowest two levels of Bloom's learning taxonomy. However, with good assignment and video structure, as called for by Myers and Nulty (2009), the higher learning levels of analyzing and evaluating can be reached. In addition, students can be encouraged to think in a constructivist fashion.

Consider, for example, an operations management course that challenges students to model and solve problems such as location analysis, forecasting, inventory systems, statistical process control and process capability. Instead of solving individual textbook problems by hand, each area is investigated in a more holistic, workshop-like approach. Students are challenged to construct and complete sophisticated spreadsheet implementations as a way to develop valuable technical skills beyond the basic course content. For example, students use the solver in Excel for optimization, perform and evaluate multiple regressions, and use many mathematical, statistical, and lookup functions. In addition, students learn how to structure spreadsheets for decision making, sensitivity analysis and error trapping, all within the context of the operations management concepts.

Interactive videos, complete with pausing and annotations, guide online students through these implementations as a means to follow the workshop approach employed by the in-person version of the class. Using lecture capture in this way follows the objectivist learning approach but the problems are designed and presented in a manner to facilitate the transference to practical and common work concerns, thereby encouraging students to think in a constructivist manner. Once the spreadsheets are built, students are challenged to analyze the results to evaluate what the practical consequences are and what decisions should be made as a result.

Live Class Capture

In many contemporary classrooms, the student profile has changed from decades past. More non-traditional students are returning to complete their degrees with work and family obligations often interfering. Indeed, it is estimated that nontraditional students now account for three-quarters of all college students (Complete College America, 2011). Of great importance, these non-traditional and over-committed students are often at risk for not completing their degree, especially when they have gaps in their studies (Complete College America, 2011). Of course instructors have always been concerned with student success, but with the recent surge in outcomes-based funding in higher education (Jones, 2013), the issue takes on increased importance.

Typically, if a student missed a class meeting, their primary recourse was to get notes from another student. With capture technology, recording live classes for review by students is possible. This can be a valuable scaffold or learner support, not only for those who get sick or must miss class for a work or family obligation, but also for students who find the material difficult and desire additional engagement.

Learning Support Repositories

Nontraditional students returning to school, and part-time students who may take breaks between learning stints, mean programs can expect students who have significant gaps between taking sequenced courses. This can be especially problematic in technical and computer-oriented courses where competencies evolve rapidly and build upon themselves. Additionally, the push to curtail or eliminate remedial education funding subsidies, and to place at-risk students directly in credit-bearing courses (Jones, 2013) makes the development of learning support repositories prudent.

Lecture capture technology can play an important role in providing an objectivist approach to developing scaffolds of learner support repositories. Instructor developed videos with tutorials and remedial assignments can be made available to students before a course begins so incoming students who need to review foundation material and concepts can do so on an as-needed, self-study basis.

Student-Created Course Materials

While instructor-recorded lectures and course materials are a popular use of capture technologies, engaging students in the course content creation is a way to achieve higher-level learning from a constructivist perspective. At the same time, useful learner support materials for future students are developed.

Consider, for example, an upper division MIS course that requires students to learn how to use Microsoft Access™ and Excel™ to solve business problems. Students entering the course have widely differing skill and experience levels, and not all students are from the MIS discipline. As part of the course, some assignments are designed to require students to create learning resources (tutorial videos) for inclusion in the course repository. Students provide their own perspective on the application as well as on the tips, tricks, and traps for the material. As an extension, requiring students to identify and propose areas with which they struggled as a basis for the materials they generate, engages students with the content in a personally meaningful, high-level learning manner.

Student-Created Documentation and Instruction Manuals

Experiential learning courses, such as internships or those that complete projects for external clients, often require documentation and instruction manuals so clients can use the student-created programs and processes after the course or internship ends. Capture technology is particularly useful in these efforts.

As part of the project documentation, students can incorporate recorded demonstrations and explanations of complex processes into manuals

or handbooks. These can then be saved to the organization's network for secure access, typically via hyperlinks in the documentation file. As a result of both the project and the recorded documentation, students reach the highest level of Bloom's taxonomy, creating, in a constructivist approach as they develop scaffolding and learning support materials for others to use.

Student Presentations

Student presentations are a traditional way to engage students with the course material and each other. In terms of Bloom's taxonomy, this technique often reaches beyond mere understanding to include the higher level learning concerns of analyzing and evaluating as students must provide their own interpretations to the findings. Furthermore, student presentations represent the constructivist and social constructivist approaches as students interact in the development process or during the presentation via questioning and discussion. Capture technology is useful for student presentations too, where rather than giving the presentation in person, they record it.

One approach is to have students create and record a presentation, including relevant discussion points. The class watches these peer-developed recordings on their own and prepares discussion questions for debate in the next in-person meeting. The student presenters then lead the discussion, becoming in effect, the instructor of the material. As a result, the students become active participants in achieving the course learning objectives, while identifying and explaining relevant examples and connections of interest to them. As an added benefit, the captured presentation becomes a resource for assurance of learning purposes.

Documentation of Exam Completion

As noted, assurance of learning and assignment integrity are important concerns in education, especially for online courses where students are not physically present during exams or for courses with out-of-class assignments. Lecture capture technology can play a role here too.

Consider, for example, a database course, where students must demonstrate proficiency on practical exams by creating tables, modifying relationships, developing forms, etc. As students complete the assignment outside of class, they are required to record themselves, complete with verbal explanations of what they are doing and why. With the exam completion videos, the instructor can not only evaluate the submitted files and work but can view the completion process as desired. Not only is this useful for evaluation or review, it is a positive step in eliminating concerns with completion authenticity and assignment integrity for work completed outside of the classroom.

Course- and Program-Level Knowledge Base

Given the myriad of ways capture technologies can be deployed and the increasing capability to capture any manner of media and input, higher education could well be entering what can be thought of as an 'omnicapture' phase of teaching and learning. In such an all-encompassing capture environment, new resources such as course-level and program-level knowledge bases become possible. The multimedia assets created, such as those discussed above, could be aggregated for use in teaching, used by students for e-portfolios, and to serve as learning documentation or even as a program's bona fides.

Consider, for example, extending the potential of student-created course materials discussed above as part of the course structure itself. Instead of having students simply read a textbook and take an exam, instructors could include assignments where students must identify areas they desire to investigate in more depth and then use capture technologies to create engaging, multimedia resources for use by others. Students would be charged with finding open-source and non-proprietary resources and to include proper citation and referencing. Instructor and peer reviews would be used to vet the correctness of the work, while a user-rating system could be employed to allow future users to vote on each work, thereby enabling the highest-rated material to surface over time. Each semester, every student and class would incrementally add to the knowledgebase, filling in underserved areas and improving upon others. Ultimately, this student-generated knowledgebase could become the foundation for not only course materials but also how the course itself is taught.

4. CONCLUSIONS

The use of lecture capture technology is becoming widespread in education. To date, though, most of the focus on using capture technologies has centered on increasing student access and instructor efficiency as lectures are recorded for students to download and watch. As such, this use is primarily a modern twist on the traditional lecture model that only reaches the lower levels of the learning hierarchy using an objectivist learning approach. In other words, the instructor projects information to the students and they are expected to retain and recall it on demand.

This paper proposes that capture technology holds promise to obviate high-order learning concerns and that it can be deployed in the constructivist and social constructivist learning paradigms where students are active participants in the learning process. Students can use the capture technology to generate new content and knowledge of importance to them, individually or in concert with others. Assignment integrity and assurance of learning concerns are inherently enhanced during this process as the recordings themselves become a record of student achievement. Ideas for how to accomplish this are discussed.

With the rapid advancements in capture technology to easily and efficiently record a host of inputs and media, the ability to develop comprehensive repositories of student-developed materials and knowledge is becoming a reality. Such an 'omnicapture' learning environment appears promising and worthy of consideration. To move towards this end, though, teaching methods, assignments, and even course and program design must be considered in concert with established learning theories and technology. It does not seem so farfetched that this time, maybe technology truly will begin to reach its promise to fundamentally impact education, teaching, and learning.

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