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A Learning Theory Approach to Using Capture Technology in Teaching: Ideas from Basic Lecture Capture to Student-Created Content

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Abstract

A confluence of technological advances is impacting teaching as new educational methods and structures are now possible. Lecture capture technologies are a particularly active area of interest where a class or lecture is recorded and then made available to students. Many university instructors are experimenting with how to use capture technology in their teaching while new entrants, such as the Khan Academy and massively open online courses, or MOOCs, which use this technology are beginning to compete for students. 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 is essentially a modern version of the objectivist approach to teaching where an expert, or "sage on the stage", projects information for student consumption. More importantly, capture technology can fit into the constructivist learning paradigm, which requires students to take what they have learned and apply it to new concerns of importance to them. This paper considers how lecture capture technology can be used to impact student engagement and facilitate both objectivist and constructivist learning. In particular, it is proposed that student-generated content is important to achieving constructivist learning via capture technology. Ideas for how this can be achieved in face-to-face and online classes ranging from computer-oriented to writing-intensive courses and internships are discussed.

Keywords: Lecture Capture, Instructional Design, Student Engagement, Learning Theories, Objectivist Learning, Constructivist Learning

1. INTRODUCTION

The promise of the internet and technology 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,

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Diebold, and Kummerfeld, 2013) and the lecture capture technology used is seeing "acceptance rates that are remarkably positive" (Greenberg and Nilssen, 2009). In its basic form, lecture capture is where an instructor records his or her presentation for viewing by students, either via a learning management system or elsewhere online. It can be as simple as a PowerPoint presentation, a video of an instructor talking, or an animated whiteboard presentation. More advanced applications may incorporate interactive videos and programs that integrate quizzing or timed pauses that require users to demonstrate proficiency in some manner before moving on. 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.

A key to the usefulness of any technology for teaching is ensuring that it matches with, and meets, learner needs. For example, capture technology, as implemented in MOOCs, are specifically designed to increase access and lower costs because the recorded videos are "open", "online", and often offered for free (Kay, et al, 2013). Furthermore, recordings give students the opportunity to engage content more intensely as they can pause, rewind, and watch repeatedly as the student himself or herself may require.

For the most part, though, 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, which is the focus of this paper.

Student-generated content is a particularly intriguing use of capture technologies, not only because it can facilitate constructivist learning principles but because it can provide assurance of learning evidence and protect assignment integrity as well. For example, student presentations, which show how the concepts they are learning fit with their work experience or interests can be recorded. In addition, for take-home or online assignments and exams, it can be used to authenticate completion. Students can be required to record themselves, which helps to insure completion veracity and for use as a learning aid during an assessment debrief. Building a database of student work can serve as evidence of a student's learning—an e-portfolio in effect—and could function as such for not only the student but for the academic program as a whole.

Designing assignments and courses using capture technologies in concert with learning theory, 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 that "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. Ideas for use are discussed and many of these approaches are currently being used by the authors. Planned extensions and future applications are also noted.

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 with an emphasis of how lecture capture can fit with the tenets of

objectivist and constructivist learning theory to achieve high-level learning is discussed. In Section three, ideas for using capture in teaching are presented. As part of this, an overview of the technology used is offered. While the examples will concentrate on teaching of computer and software-oriented courses, the authors' area of teaching, the ideas are readily applicable to other areas.

2. LITERATURE REVIEW

Lecture Capture

The use of lecture capture in higher education has been an active area of research. 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. All of these works, however, concentrate at the lower levels of learning taxonomy and on an objectivist approach.

The use of student-generated lecture capture in higher education is much less pervasive even though it holds promise for higher-level 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. These were reviewed and critiqued by the instructor and were used in class for peer review and critique. This work by Shafer (2010) is significant in that it is the only one we have found to date that explicitly considers learning theory, Bloom's taxonomy, in deploying the capture technology.

Learning Theory

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.

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 one on the topic, and then retested.

This is not to say that objectivist learning approaches and lower order learning concerns are unimportant, because they are 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.

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.

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) states 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).

Employing capture-based technology in a holistic design approach, especially in online courses with student-generated content, addresses what noted organizational studies researcher John Seely Brown posited in 2008:

> *I think we are really going to see much more learning by doing. And then when you get stuck, engaging in productive inquiry of the things that you don't know in order to do the things that you need or want to get done. Instead of spending your time learning 'about' and then turning around and doing some homework that uses that knowledge, you might reverse that whole cycle—like saying, 'Well, let's start doing things that we really care about and then start expanding our understanding' (p. 61).*

It is interesting to note that this mantra was initiated nearly a century ago by John Dewey

(1916) in his seminal work *Democracy and Education*. Dewey contemplated the process of learning outside of school, i.e. ordinary life, where he noted that students necessarily draw on these experiences in order to make sense of what they are subjected to in the classroom. These experiences, he said, "give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results" (Dewey, 1916, p. 181).

In modern society, these concerns extend to collaboration and the ability to work well with others to accomplish a goal. As such, 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.' Even when work is performed in collaboration, though, it is fair to say that employers and educators are interested to know what value each individual contributed to the effort. In constructivism, learning is often prized as a unique experience, 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 measure 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).

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 examples of how lecture technology is being employed by the authors in concert with learning theories. Planned extensions and ideas for the future also discussed. First, though, the lecture capture programs utilized are introduced.

Lecture Capture Programs Utilized

Three different capture programs have been used in the applications discussed below: Jing, Captivate, and Panopto.

TechSmith Jing

Jing, a free software program from TechSmith, is a basic screen capture and recorder that can grab entire screens or specified regions, which can be converted to pictures or videos. Captured content can be uploaded to TechSmith's streaming site, ScreenCast.com, or saved to a Flash (SWF) file for distribution. Videos are limited to five minutes and Jing does not have editing features. However, videos can be edited in Camtasia Studio, TechSmith's full-featured capture suite, if desired. Jing is particularly useful for basic instructor videos and student-generated content and it is simple to learn for new users.

Adobe Captivate

Adobe Captivate is a full-featured capture and editing system that can be purchased standalone or as part of Adobe's eLearning Suite. Captivate supports a wide range of capture devices, media and web formats, as well as learning management system protocols. Advanced editing and post-production of videos are possible, including the addition of interactive elements, table of contents, branching, and integrated quizzing, among others. It is particularly well-suited for software demonstrations. Videos may be uploaded for streaming from Adobe, YouTube, or from an instructor site, as well as shared privately for offline viewing. Captivate is a powerful program, with commensurate complexity, that can be used individually or as an organization-wide system. As a standalone product, Captivate costs about $300 for an academic license.

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Panopto

Panopto bills itself as "The All in One Online Video Platform" that is positioned as an institutional-level system. Panopto videos may be saved as WMV files for offline viewing or on a Panopto server for streaming, the latter of which is how Panopto is used in the examples below. Panopto has basic editing capabilities where videos may be appended together and sections of videos may be removed but little else. Hosted Panopto videos can have a table of contents, searchable metadata, integrated note taking by students, and include content such as PDFs and external videos. Panopto can integrate with Blackboard or Moodle, can capture a wide array of input types, and is particularly well-suited for PowerPoint presentation capture. Panopto can be used by instructors and students alike to generate content, which can be made public, kept private, or associated with specific course sections. Panopto is typically purchased or subscribed to by a campus or institution, and became available to the authors during the 2012-2013 academic year.

Lecture Capture Applications

Pre-Recorded Lecture Videos

Pre-recorded video lectures were created using Captivate to enable an operations management course to move online. These videos are deployed similarly to most lecture capture applications but are interactive and periodically require student input. They cover the course's conceptual material. Feedback from students in spring 2013 concerning the videos was very positive. All students reported watching the videos with 84 percent (21/26) reporting that the videos had significant impact on their learning, while another 15 percent (4/26) indicated a moderate effect. In addition, 92 percent (24/26) felt that the videos were very or moderately helpful in understanding the course material in general, and 84 percent (22/26) felt that the videos helped them to pick up on things they missed in reading the textbook. Open comments from students included the following:

> *(The videos) made it feel like I was sitting in a normal class lecture.*
>
> *The videos are a great addition to online classes, I really felt I was in the classroom.*
>
> *This use of technology greatly enhances the learning process which is often more difficult with distance learning.*

Hence, by employing videos in the course, online students were readily able to engage with the material and improved their learning experience.

Pre-Recorded Solution Videos

The online operations management course requires students to complete sophisticated spreadsheet implementations as a way to develop valuable technical skills. During the semester, students use the solver in Excel for optimization, perform multiple regressions, and use many mathematical, statistical, and lookup functions. In addition, students learn how to structure spreadsheets for sensitivity analysis and error trapping. Interactive videos, created using Adobe Captivate, guide students through these implementations as a means to follow the workshop approach employed by the in-person version of the class. The lecture capture use 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.

Students in the fully online operations management course responded positively as more than 95 percent (22/23) agreed or strongly agreed to the Student Survey of Instruction (SSI) statement "I learned valuable information/skills from this course". Student comments included:

> *This class was great as what I learned I could use at work.*
>
> *This is the best online class I have ever taken. I did struggle a lot but it was because the course material was hard for me.*
>
> *This system helps students to learn the subject more in depth and to understand it rather than just reading it out of the book.*

Thus, through capture technology, complex and meaningful computer-based problem solving can be successfully transferred fully online.

Live Class Capture

It became possible in spring 2013 for live class meetings to be recorded using Panopto and this capability was employed for a project management course. Students found this course particularly challenging due to the complexity of using MS Project.

In the course student evaluations, nine of ten students reported that they learned valuable skills in the course and that the equipment and technology used supported their learning. Student comments on Panopto indicate they appreciated the extra ability to engage the material, including:

> *Being able to review the class at home through Panopto was invaluable. Wish that option was available in all my classes.*
>
> *Panopto helped.*
>
> *Class recordings using Panopto worked great for review.*

Student Created Instruction Manuals

An experiential learning course or component of a course is required of all students at our university. Students in our program get credit for an internship or a business consulting course, a team-based practicum course that works with external clients. Students in both courses create deliverables for their clients or employers. Jing has proven useful here. Students incorporate recorded demonstrations and explanations of complex processes into process documentation manuals or handbooks. These can then be saved to the organization's network for secure access, typically via hyperlinks in the documentation file.

Student Presentations

In a writing-intensive global business course being delivered in a blended format during summer 2013, students are required to prepare recordings of concepts, theories and practices relevant to the global marketplace and write-up their interpretations thereof. In addition, students develop discussion points for the subsequent class meeting. The student created recordings are being made using Panopto, where they are either standalone presentations or they are in conjunction with interactive PowerPoint slides. The class watches these peer-developed recordings online and prepares discussion questions for debate in the next class meeting.

At the time of this submission, the course is approximately halfway complete so final student feedback will be added later. A preliminary assessment, though, is strongly positive. In making the recordings, students show a distinct concern for the quality of their work that is encouraging and impressive. The students are active participants in achieving the course learning objectives, while identifying and explaining relevant examples and connections of interest to them. This changes the entire class dynamic and gives students ownership in making the course a positive learning experience for everyone involved as it simultaneously documents their individual contributions. Given the quality of their efforts to date, students should have confidence that they can share their work with potential employers knowing it will help their candidacy and that it will speak well of our program too.

Student-Generated Course Materials

Student-generated content was introduced into an upper division MIS course. This course challenges students to learn how to use MS 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. During the spring 2013 semester, students focused on creating learning resources for future students, who would use these materials for self-study and subsequent improvement. Student survey results are forthcoming. Meanwhile, instructor observations note that spring semester students were much more engaged with the extent and complexity of the material and thereby advanced their interest in and engagement throughout the course.

Documentation of Exam Completion

In this same spreadsheet and database MIS course during the summer, students are using the Panopto System to record completion of online exams. These exams are practical in nature and require developing specified spreadsheet applications or entire database systems. With the exam completion videos, the instructor can not only evaluate the submitted files and work but can see the completion process as desired. Not only is this useful for evaluation, it is a positive step in eliminating concerns with completion authenticity and assignment integrity for work completed outside of the classroom.

Learning Support Repositories

Students in our program are typically business majors with decent computer skills but who often struggle with the most technical courses in the program. Developing databases, advanced spreadsheet implementations, and project management are especially difficult for many of them. Student support materials, created with

Captivate and Panopto, are being developed to provide scaffolds for learning.

The total quality management (TQM) class requires students to complete a course project. A TQM student, who had just completed the database course, decided to use Captivate to create tutorial videos for use by students in the database class. These videos provide remedial resources for students who may not have used database software for some time and do not remember the expected basics. With the addition of Panopto on our campus, we look to expand the development of student-generated, computer-oriented tutorials. Our campus has just been certified as a Certiport exam site for Microsoft Office Specialist (MOS) exams. A tutorial video repository should be a valued resource for student self-study in exam preparation because while students get broad exposure to the Office programs in their studies, our curriculum is not intended to cover all aspects of these tests. However, piece-by-piece over several semesters, students in our spreadsheet and database courses could create the many lessons needed to cover exam skills.

In the project management course, instructor-generated videos are being created in Panopto for aggregation into a video support repository. Two types of videos are being created, short (one to three minute) technically-focused ones on how to accomplish specific tasks using MS Project and longer (five to ten minute) videos that focus more on why a specific Project capability is used. Videos are planned for all aspects of how Project is used in the course and will number in the dozens to perhaps a hundred when complete. Panopto videos are fully searchable for keywords and metadata so students can readily find items of interest. Students who need help on a topic could search the video repository using key words from an assignment, for example, and find a technically-oriented video to assist them or a short lecture video that will reinforce why they would want to do so.

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 we think 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 could be aggregated for use in teaching, used by students for e-portfolios, and to serve as learning documentation or as a program's bona fides.

Consider, for example, the potential of student-created course materials in teaching. 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 employed as a means to allow future users to vote on each work enabling the highest-rated material to be identified 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 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 a constructivist learning paradigm 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. Ideas for how to accomplish this are introduced and discussed.

With the rapid improvements 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 is already changing how we are approaching our teaching methods as well as our approach to assignment and course design to be in concert with established learning theories. 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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