Abstract

"Podcasting" and "Vodcasting" have received particular attention as way to send or push content to students. These techniques show promise, but arguably can create a more passive learning environment. Our program methodologies seek to utilize current technologies to facilitate the development of self-learners in an active learning environment. Using screen capture software, we created Video-based Additional Instruction (VAI) for a General Chemistry course to foster problem solving skills and conceptual understanding of course material. We linked VAI as a supplemental resource to an online syllabus that required students to seek or pull content as needed. We used surveys and website hit counter data to determine when and why students use the resource and surveys to determine its perceived benefit. Initial self-surveys show-overwhelming use of the resource for both pre-class preparation and pre-test review with nearly 80% utilizing at least 50% of the videos available. Students agreed that it improved their conceptual understanding and their problem solving skills. The initial data suggests that videos in a pull content show great potential in supporting an active learning environment as well as providing additional on demand support outside of normal office hours.

Background

Educators have introduced new technologies into the classroom to enhance the learning process. Technology has the capability to increase student motivation while providing unique instructional capabilities. It can also support new pedagogical approaches and assist in the development of information and visual literacy. Furthermore, it has the potential to increase teacher productivity (Roblyer, 2003). In

particular, “podcasting” and “vodcasting” has emerged as a way to meet students on their own technological level. Since the Duke study (Belanger) in 2005 on podcasting, educators have sought to expand the classroom environment by recording lectures for students to review at a time and place of their choosing (Byrne, 2007; “UChannel;” Komanecky, 2008; “Video at MIT”). This has allowed teachers to send both audio and video files through subscriber lists to their classes. As evolving technology becomes more readily available, the use of video is becoming increasingly more prevalent due to its visual presentation capability. Unlike audio only, the use of video has made it more attractive for use in math, science and engineering courses. In particular, the use of visual media is crucial in demonstrating multi-step problem solving approaches.

We incorporated a similar technique into the General Chemistry course at the United States Military Academy. Cadets master the various course objectives that further support the institution’s Academic Program goals. These goals seek to instill in the Academy’s graduates key skills such as problem solving in a complex and changing world, gaining and understanding of how to incorporate technology to support problem solving and developing the habits of mind to support life-long learning (“Educating Future,” 2007). However, some have serious concerns about the pedagogical implications of introducing or casting audio or visual files of classroom content. Most of the concerns center on the potential drop in classroom attendance or in-class participation (Meng, 2005; O’Connor, 2005). Another overarching fear is that educators coddle immature learners to become ever more passive in their learning and thus retarding their development as self-learners.

The teaching philosophy of the Department of Chemistry and Life Science still espouses the Thayer Concept (Ertwine, 1987; Pallidino, 1979) where instructors expect students to prepare for class and come ready to recite homework. Students recite homework by working solutions to similar problems at individual chalkboards during normally scheduled class. In current educational terms, the classroom environment seeks to mirror that of an active learning environment with an emphasis on problem-based learning (Rhem, 1998; Bonwell and Eison, 1991; "University of Delaware;" Prince, 2004). As part of their daily lesson preparation, students complete a reading assignment and homework problems while maintaining the option to view supplemental resources that include animations and tutorials to further conceptual understanding. Textbook publishers professionally develop many of the animations and tutorials we use while a few are open source amateur created videos. Our goal was to leverage the video technology and create screencasts focused on problem solving approaches to historically challenging topics in chemistry. We named the screencasts Video based Additional Instruction (VAI) with the intention of modeling expert problem-solving processes without creating a passive learning environment.

We developed a strategy to focus on the benefits of introducing video-based technology while mitigating concerns of passivity. We linked the VAI to an online syllabus and a separate VAI webpage on the course website. This allowed us to target student's motivation by increasing perception of control (Relan, 1992) as they had the freedom to use the resource as needed on demand. A key tenet of the process was to encourage their development as self-learners and, unlike "casting" the media to the student, this ensured that the student must actively seek out the information. Forcing

students to seek out help and information also supported metacognitive development. It also eliminated the passivity of students waiting for the instructor to send out the important information. Each VAI remained active for the entire duration of the course; consequently, it expanded the learning environment and provided the learner with a unique instructional resource (Miller, 2001; Relan, 1992). We utilized the media to scaffold the student through the problems by modeling expert problem-solving strategies in order to reinforce the problem-solving process taught in the course.

Using VAI has the potential to increase teacher productivity both in and out of class. The VAI problem usually demonstrated the solution to an in-class problem that mirrored the homework. The primary purpose was to keep the onus on the student to complete the assigned homework problems without copying an approved solution from the video session. The secondary goal was to have students come to class more prepared and ask more directed questions thus making better use of class time. Outside of class, unlike most institutions where office hours are limited, office hours can occur anytime during non-teaching hours of the academic day and VAI can potentially reduce office hours workload.

We used Techsmith's Camtasia Studio (Camtasia Studio Tutorials) screen capture software and Windows' Journal software on an IBM ThinkPad tablet to create each screencast. Problems were selected from the course textbook (Silberberg, 2006) and represented traditionally challenging topics for students. This eliminated the repetitiveness of simply recording classroom discussions. Moreover, it focused on specific topics integrated into the overall lesson rather than a stand-alone lecture of the class. The videos were relatively short (approximately 10 minutes or less) and allowed

for high quality screen recordings. Unlike many digital recording devices where the files are extremely large or poor in quality, the data files were easily manageable due to the length and type of media.

This study focuses on the effects of introducing VAI and we divided the research question into three parts. How often and how were the students using VAI? What was the impact to the student and the classroom? Ultimately, did the benefit to the student outweigh the potential negative pedagogical impact or instructor time required for creating the VAIs?

Method

Participants

The study took place during the fall semester of General Chemistry in 2007 at the United States Military Academy at West Point. The course had an enrollment of 1074 students with the following demographics located in Table 1. We did not separate the course into control and experimental groups based on a self-imposed mandate to maintain equity (perceived or real). Twenty instructors that varied from first year faculty to tenured professors taught the course. Regardless of the instructor, all classes were required to use the same textbook (Silberberg, 2006), course material, objectives, and exams.

Data Collection

Both qualitative and quantitative data was collected though the following means: mid-course and end of course surveys, website hit counter data, beginning of class quizzes, and both instructor and student feedback. We anomalously administered the

mid-course survey to one-third of the course students between lessons 16 and19 of a 40-lesson course. Instructors collected the four-part survey from a sample of their students. The first part of the survey determined the usage of VAI by asking if they had ever used VAI. For those responding with No, students were required to state their reason for not using the resource. For those that responded Yes, students proceeded to the following selections to determine their frequency of use: once, twice, 3-5 times and more then 5 times. The next two sections used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) for a series of statements on when they used VAI and how it benefited their problem solving skills and conceptual understanding. The last section allowed free text response to the following questions: what they liked best about VAI; how did it help their learning; and what did they not like about VAI.

We administered the end of the course survey anonymously through the internet. We recorded responses to four historically asked questions using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) that we used as indicators for student development as a self-learners and problem solvers. Students responded to an additional three questions regarding VAI usage, usefulness, and comparison to other traditional resources available. Web hit counter data tracked the number of individuals that viewed a VAI during the entire semester by lesson. Instructors were asked to report any feedback either solicited or unsolicited from students regarding VAI or the impacts of VAI in the classroom.

We administered beginning of class quizzes to a small subset of students to measure comprehension of specified learning objectives. The questions mirrored homework problems and had a companion VAI session. We asked the following three

questions on a series of quizzes: Question 1, find standard change in enthalpy for a given reaction; Question 2, write the full electron configuration for a given element; and Question 3, draw the full orbital diagram for given element. We administered the quizzes without notice at the start of class prior to any discussion of the day's material. Students also responded to whether they watched the corresponding VAI session.

Data Analysis

We calculated means and percentage responses for all the responses on the surveys. The four annually asked end of course survey questions were compared the average response over the previous five years. The qualitative survey data was to determine how and when the students used VAI. The surveys also provided understanding to the students' perceptions of the effectiveness of the VAI. Free text responses were analyzed using thematic data analysis and we grouped them inductively to determine trends.

We used the quantitative data from the web counters to validate the self-reported usage. For each the quizzes, we classified the experimental group as the ones who viewed VAI and the control as the ones who did not use VAI as part of their lesson preparation. Using the quiz grade, we calculated the increase/decrease in percentage points from their current course average (quiz average minus current course average). We subsequently preformed a t-test to see if there was a statistical difference between the control and experimental groups.

Results

From the midcourse survey of 367 respondents, nearly 85.15% used VAI at least once. For this study, usage is defined as a user activating the VAI recording regardless of whether the watched the entire video or whether they watched the video multiple times. Of those that did not use the resource, most reported they did not use it because they felt confident with the material from the reading. For those that used VAI, 75.40% reported that they had used the resource at least three times and 33.73% reported using the resource more than five times from eight videos available. Students reported whether they used VAI before class as a preparation tool, directly after class to review, or after class to review prior to a test. Many students reported using the VAI a study tool prior to graded events; however, a large majority of those who reported using VAI did so as part of their lesson preparation prior to class (Table 2).

The free text feedback by the students has been positive (see excerpts). The positive comments centered on the following trends: a systematic problem solving approach, the on-demand availability, the pause and rewind capability, and the visual nature of the media. The most common suggestions were to create more VAI sessions and for a larger variety of topics.

> "I like how it goes step by step and you see the problem being worked. I like how you can pause the problems and go back until you understand the material."
>
> "It shows me how to solve the problems, where the different values come from and what they mean. In the book examples you are just given the values and the solution. It is difficult sometimes to figure our how the book is trying to solve the problems."
>
> "I can stop and compare my work to the video AI work. I am able to rewind the video to the exact spot I want and review the concepts."
>
> "I like the visual interaction and it helps me stay engaged in chemistry."
>
> "I like that Video AI is easy to access and can be used at anytime."
>
> "There should be more problems."

Table 3 summarizes Likert scale means and percentages for responses to the following statements, "Video AI does a good job": at helping me learn problem solving, breaking down the problems, explaining the concepts, and helping me understand the material. Students generally agreed that there is a perceived value to VAI with the greatest positive impact reported in breaking down the problems.

As part of the end-of-course survey, 759 students responded to three specific questions regarding VAI (Table 4). Ninety percent of students reported using VAI during the semester while 54% reported they used it always or frequently. Over half of the respondents reported that VAI was a very useful and only a small percentage reported the media as not useful or they were neutral towards it. Table 5 shows student responses to four annually asked questions. The results reported are those who strongly agreed with the statements as compared to the same questions average response over the previous five years. Fifty-six percent of students strongly agreed that they were responsible for their learning that was an increase of 5% over the five-year average. Twenty-six percent of the students strongly agreed that their study skills increased which is an increase of 6% over the five-year average. Twenty-seven percent of students reported that the course improved problem solving, critical thinking and analytical reasoning which is an increase of 4% over the five-year average.

For the small subset of students sampled, those who used VAI consistently preformed better than expected versus those who did not use VAI as part of their lesson preparation (Table 6). Table 7 reports the web hit counter results with an average usage per lesson of approximately seventy percent.

Discussion

The usage reported from both surveys and the web hit counter data suggests a strong usage for the media as 90% of the course used VAI. The large percentage of users occurred despite VAI not being casted or sent through subscriber lists. Students also reported that they not only used VAI as a study tool for examinations but they also used it prior to class. Students consistently agreed that VAI contributed to their learning and 82% stated that VAI was at least somewhat useful. We compared the end-of-course survey questions from the past five years to determine if there was there a negative impact either to the learning environment or to the development of self-learners. The 5% increase in percentage of students who strongly agreed that they were responsible for their learning. This coupled with a 4% increase in the student's motivation to learn shows no noticeable negative impact on student perceptions on their development as learners. Twenty-six percent of the students strongly agreed that their study skills increased which is an increase of 6% over the 5-year average. Twenty-seven percent of students reported that the course improved problem solving, critical thinking and analytical reasoning which is an increase of 4% over the 5-year average. The limited performance testing tends to support improved problem solving capabilities by the students. We cannot attribute the increases solely attributed to VAI, but the results remain encouraging.

Based on the unique situation at West Point, reduced attendance levels due to students skipping class was not a concern. However, we had nine-hundred excused absences from class for numerous reasons. The reasons included both academic and athletic trips, health reasons, and small portion (only 1%) was unexcused. VAI has the potential to mitigate the negative impact of students missing these classes legitimately.

Moreover, VAI scored consistently higher then traditional additional instruction (office hours) as far as the overall contribution to the students learning. We see the potential for VAI to reduce time dedicated to traditional one-on-one additional instruction.

Conclusion

Based off student responses and web hit counter data, a large number of students used VAI both prior to class and for lesson preparation. We did not see a drop in student preparation or participation in class due to the introduction of VAI. In fact, instructor observations of students indicated that students asked questions that are more specific and engaged in classroom discussion more frequently. Moreover, students reported significant benefits to using VAI as part of the overall course. The preliminary test scores initially support the self-study data of increased individual learning. We have concluded that potential benefit to the student outweighs the administrative impact to the instructor creating the screencasts. Moreover, we saw no appreciable negative impact the student as a self-learner and see a greater potential to increase their problem solving abilities. These initial conclusions remain preliminary and in the second year of the study, we will complete a more comprehensive quantitative correlation of individual student performance gains and VAI usage.

Table 1. Student Composition	
Student Details	Percent Composition
Gender	
Male	891/83%
Female	183/17%
Class Year	
Freshman	1024/95.3%
Sophomore	50/4.7%

Table 2. Mid-course survey: Student use of VAI			
Response	**Before Class**	**After Class**	**Test Prep**
Agree	60.00%	36.00%	77.90%
Disagree	17.45%	33.82%	11.59%

Table 3. Mid-course survey: Responses to Video AI does a good job				
Question	**Mean**	**Disagree**	**Neutral**	**Agree**
At helping me learn problem solving	3.97	4.4%	19.2%	76.4%
breaking down the problems	4.21	2.2%	10.8%	87.0%
explaining the concepts	3.87	6.9%	24.0%	69.1%
helping me understanding the material	3.98	5.5%	17.8%	76.7%

Table 4. End of course survey.

Frequency of Use	**Always**	**Frequently**	**Sometimes**	**Rarely**	**Never**
How often did you use VAI?	175 (23%)	236 (31%)	173 (23%)	106 (14%)	69 (9%)
Usefulness	**Very Useful**	**Somewhat Useful**	**Neutral**	**Not Useful**	**Did not use VAI**
How useful did you find these sessions in helping you prepare for daily lessons and graded events?	420 (55%)	207 (27%)	42 (6%)	9 (1%)	81 (11%)

Rank order the following resources in order of their usefulness in preparing for daily lessons and graded events and their overall contribution to your understanding/learning in this course.

	1	2	3	4	5	6
Learning Objectives	109 (14%)	111 (15%)	144 (19%)	130 (17%)	153 (20%)	112 (15%)
Video AI	150 (20%)	150 (20%)	148 (19%)	104 (14%)	111 (15%)	96 (13%)
Animations and Tutorials	27 (4%)	100 (13%)	126 (17%)	165 (22%)	170 (22%)	171 (23%)
Course Textbook	109 (14%)	130 (17%)	124 (16%)	152 (20%)	112 (15%)	132 (17%)
Additional Instruction	111 (15%)	115 (15%)	104 (14%)	116 (15%)	144 (19%)	169 (20%)
Classroom Discussion	253 (33%)	153 (20%)	113 (15%)	92 (12%)	69 (9%)	79 (10%)

Table 5. End of Course survey Data				
Question	**AY08**	**5 Year Average**	**AY08**	**5 Year Average**
Were students encouraged to be responsible for their own learning	**56%**	**51%**	**4.52**	**4.45**
Has motivation to learn and to continue to learn increased	**31%**	**27%**	**3.93**	**3.83**
My study skills have been increased because of the course	**26%**	**20%**	**3.89**	**3.78**
Improved problem solving, critical thinking and analytical reasoning	**27%**	**23%**	**4.05**	**3.95**

Table 6. Comparison of Student Performance: Experimental Group versus Control				
Performance Measure	**Experimental Group**	**Control Group**	**Difference (Exp – Control)**	**Significance of Difference**
Question 1	15.2% (N=16)	-13.1% (N=16)	28.3%	Yes P<0.005
Question 2	0.7% (N=10)	-54.5% (N=17)	55.2%	Yes P<0.0001
Question 3	-9.3% (N=10)	-61.2% (N=17)	51.9%	Yes P<0.005

Table 7. Web hit counter data for each VAI session by Lesson		
Lesson	**Topic**	**Number of Hits**
2	Dimensional Analysis	330
7	Combustion Analysis	974
9	Limiting Reactants	838
11	Solution Chemistry	778
13	Molecular, Total Ionic, Net Ionic Equations	1037
14	Titrations	1262
18	Gas Law	922
20	Coffee Cup Calorimetry	880
22	Heat of the Reaction	821
24	Explosives – Predicting gaseous products	304
27	Electron Configuration	578
29	Lewis Structures	539
32	Heating and Cooling Curve	672

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