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TEACHING MATHEMATICS USING LECTURE CAPTURE TECHNOLOGY

Diana Audi
Mathematics Department, American University of Sharjah

Abstract: Technology in higher education is dramatically changing and continuously giving a challenging time for educators and institutions to provide the same level of innovative contents, environment and interaction to a digital native generation which is well powered with technology. It has been well observed and recognized that video lectures technology can have positive impacts on student learning and satisfaction however research on Mathematics intensive subjects have yet to be fully explored. This exploratory evaluation seeks to examine students' experiences and perception on receiving lectures via a digital lecture technology, and to assess using statistical tools the benefits of those video lectures on student performance in a mathematics intensive subject for freshman students at the American University of Sharjah, UAE. The concept of introducing rich text format lecture capture technology in Mathematics subjects (Math for Business and Calculus 2) was rigorously analyzed on a total sample of more than 300 students over multiple semesters. Both control groups without using any form of technology and experimental groups with using the proposed technology were compared in terms of student acceptance and academic performance improvements. Both qualitative and quantitative analyses were used and the results are very promising. Students saw the added benefits and found the technology very useful.

***Keywords*:** Video lectures, lecture capturing, teaching and learning technology, innovative learning technology, student performance, mathematics teaching.

Introduction

In recent years, there have been a number of noticeable advancements in lecture delivery including the use of lecture capture technologies, wireless voting systems, digital tablets in classrooms, mobile applications, augmented reality tools, and virtual reality among others. Lecture Capture technology includes the recording of the classrooms or special event activities by using a combination of dedicated software and hardware. Recordings are stored digitally and available electronically for students or participants to learn, view and observe at a time convenient to them. Lecture capturing has been there for a while dating back to 1960s where it was used to record only audio lectures in UK. In 1980, Australian Universities started capturing lectures at a mass scale and in the 21st contrary Lecture Capture technology comes under a "should-have" category among most academic institutions. Many institutions around the globe are currently using or adopting the technology and a lot of research has already been in place on the same topic. Many studies discussed evident benefits of video lectures on the student's learning experience in several contexts however different subjects at different academic levels pose several challenges in preparing and delivering such video lectures and result in different student acceptance and satisfaction. Many universities have introduced a range of technological services to support students due to their changing nature in higher education. Students prefer flexibility options, diversity in delivery, and the opportunity to spare extra time before and after classes. Although many benefits have been recognized for lecture capture technology but still many lecturer and faculty argue that it could not be the replacement of the face-to-face learning depending on the subject being delivered and can only be used as an extra material to help students but not the replacement as in classroom there are many activities in which student are not able to participate if they don't attend the class. To analyze some of the existing limitations of lecture capture, this study focuses on the applicability of video lectures in a technical mathematics subject that covers a number complex concepts which students have found difficult and its effects on student performance.
To evaluate the effectiveness of our proposed approach, the video lecture technology was adopted with a total of 136 university students enrolled in two major mathematics subjects: s for Business (Math 101) and Calculus 2

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*Corresponding author: Diana Audi- E-mail:Daudi@Aus.edu

(Math 104) in fall 2016 and spring 2017 respectively. Math 101 covers coordinate systems and graphs, matrices, linear systems and applications, elementary linear programming, set theory, counting techniques, permutations and combinations, probability, and mathematics of finance. The subject emphasizes mathematical techniques and applications. Math 104 covers techniques of integration, hyperbolic functions, improper integrals, arc length, surface area, infinite series, power series, convergence tests, parameterized curves, polar coordinates, integration in polar coordinates and complex numbers.

Four sections of the same subjects taught from 2013-2016 by the same instructor covering the same material with comparable exam difficulty levels were used as a control group. Average GPAs of the students enrolled in the both the control and experimental groups are usually similar over previous semesters eliminating any possibility of bias. Mobile devices were adopted to enhance learners' experience, provide immediate access to information online, and provide enhanced hands-on learning. The empirical results demonstrate that the experimental condition, 5E mobile inquiry learning, had a positive impact on participants' learning motivation and scientific inquiry abilities. The rest of this paper is organized as follows. In Section 2, we provide a comprehensive review of related research work lecture capture technologies research in education. In Section 3, we provide our research methodology and approach. We present and analyze the results in Section 4 and conclude this paper in Section 5.

Related Work

Lecture capture technology has been used during the last decade extensively and there have been numerous research output analyzing both its implications on student attendance and its positive effects on student performance. Accessing video lectures after attending the lectures has been a norm for both normal students and also distance learners who do not attend the lectures physically as researched by the authors in (Woo, K. et al., 2008). In general, students find video lectures very helpful as it gives them better time management beyond the normal classroom especially for students who might have other off campus responsibilities as discussed in a number of research papers (Soong et. al, 2006; Williams et. al, 2007; Gosper et. al, 2008). Handicapped students or students with learning disabilities tend to find video lectures way more useful compared to normal students since it allows them to go over the lectures during their free time in private settings over and over (Williams, 2006). Also, students who are non-native English speakers find video lectures very helpful and useful especially if it can be combined with captions or tagged with keywords (Williams et. al, 2007; Leadbeater et al., 2013). Research on when students usually access the video lectures showed that they usually view lecture recordings more actively at the early stages of the academic year or semester and their involvement typically decreases linearly as we progress during the semester (Phillips, R. et al., 2011). Also, students usually see the added benefits of the video lectures just before major assessments or exams to supplement their written notes or teacher notes. Regarding the effects of video lectures on student performance or learning experience, there have been contradictory research results. For example, the authors in (Von Konsky et. al, 2009) discuss the positive usage of video lectures by top students to combine them with regular class material while (Phillips, R. et al., 2011) argue that there is a positive correlation between recurrent usage of video lectures and student motivation and performance. They also pointed out that the decrease in student attendance on campus since they have video lectures has minimal effect on their performance. On the other hand, there are a number of research work that do not see the added benefits for video lectures but on the contrary claim that they might even have negative effects on student learning including the works in (Leadbeater, W. et al., 2013). Overall, most studies agree that recorded lectures has little to no effect on student attendance (Holbrook et. al, 2009). On the other hand, the negative effects of video lectures and lecture capture technology in general were highlighted in (Gorissen et. al, 2012). The reasons discussed included normal deteriorations in attendance over an interval, the development of students' skills and reliance on technology and not being able to attend due to physical or mental disabilities. Regarding the percentage of students who would opt to use video lectures if they were available, there have been a number of research work that confirm that most students at different academic levels would chose video lectures over normal lectures notes in their course of studies (Inglis et. al, 2011). For example, both the authors in (Gorissen et. al, 2012) and (Soong et. al, 2006) collected results from surveys of more than 1000 students across several European universities and found that over 90% reported accessing video lecture recordings outside of campus and found them to be useful. Also, the authors in (Soong et. al, 2006) also found that video lectures did not discourage students to attend lectures and on the contrary encouraged them to attend and video lectures has a positive effect on student performance. There are majority of work conducted on different academic levels for different subjects and positive correlation between video lectures and academic performance was noted (Williams et. al, 2007). For example, (Gosper et. al, 2008) showed that about 3/4th of students believe video lectures helped improve their results, and even more students felt that video lectures made it easier for them to learn. Also, reduction in anxiety was reported by most students in (Traphagan et. al, 2009). With relation to studies on specific subjects and the acceptance of the students accordingly, several studies were conducted on medical students and the effects of video lectures on student performance on their Medical College Admission

Test (MCAT) results (Leadbeater et al., 2013). The results were not statistically different showing minimum improvements in using video lecture technology. Also, a survey conducted by the authors in (Owston et. al, 2011) on about 1000 students in a social sciences subject found that the rate of access to recorded lectures was significantly related to student grades. In depth investigation also found that the more the students access the video lectures per month, the higher their grades were indicating the positive effects on student performance. Another subject that was investigated was a freshman and sophomore level Biology subject where the authors in (Holbrook, et. al, 2009) found that freshman students using video lectures were more expected to miss lectures than sophomore students.

In a work that resonates with ours, the authors in (Craig et. al, 2009) analyzed the different options that several sophomore students used to access subject material online over two years. They found that after normal PowerPoint slides downloads, Rich Media formats (which synchronize Audio with PowerPoint in their online format) were accessed the most (22%), while whole video lectures which were available to students as well were accessed the least (10%). A major reason behind that was the perfect alignment of the teacher's audio to the slides being presented allowing the students to move at their own pace slide by slide. Some other notable work includes the work by (Van Zanten et. al, 2012) where they researched students' inclinations for short summary audio podcasts and full length video podcasts. They found that audio additions were downloaded more and students preferred them over normal video lectures. They used the audio formats to remind them of major course content to review before real exams and major assessments. Students noted that full length video lectures were sometimes time consuming and could become boring compared to direct access to slides and augmented audio. To conclude, most researchers agree that students find video lectures to be a useful and helpful and would probably increase their academic performance if used with conjunction with live lectures. There is an evident research gap on video lectures or PowerPoint slides augmented with audio on technical mathematical subjects and the corresponding effects on performance.

Methods

In this research work, we are primarily concerned with the following research questions:

- What are the effects of augmenting PowerPoint slides with teacher's audio and handwritten notes recorded during the live lectures on academic performance in Mathematics subjects?
- What are the students' perception of the video (slides + audio + notes) lectures?

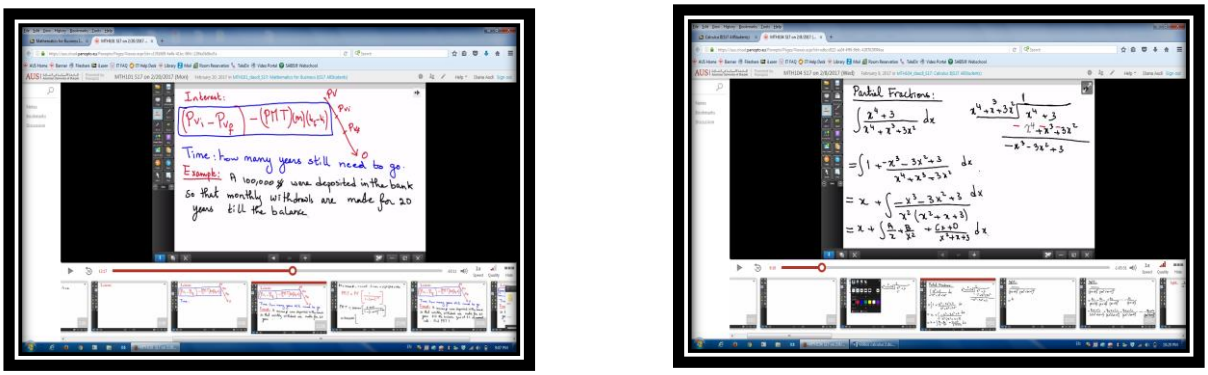
To attempt to answer the above research questions, we applied our proposed technologies on two different mathematics subjects over the course on one year (experimental group) and compared our results with the performance of students in previous semesters during the two years before (control group). The experimental group consisted of 136 students and the classes were equipped with an audio recorded synced with the interactive screen, installed lecture capture software and a digital stylus. Once the lecture was recorded, the lecturer built the content to be uploaded on the university's learning management system. Students were encouraged to attend the class as a regular face-to-face classroom and they were informed that these lectures will also be available online for them to review or in case they missed any lectures. During the whole semester the student behavior, performances as well as technology stability were monitored. In addition to the primary performance data, a descriptive survey was conducted to measure student satisfaction with the technology after the first exam and also at the end of the semester. The control groups consisted of the same subject (Math 104) taught by the same instructor over the last years and the performance of the students in the first midterm was collected and analyzed. A summary of our sampling size and data collection techniques used for both the experimental and control groups is summarized in table 1.

Table 1. Data sampling

EXPERIMENTAL GROUPS	TITLE	SAMPLE SIZE	SEMESTER
MATH 101	Math for Business	70	Fall 2016
MATH 104	Calculus 2	66	Spring 2017
	TOTAL	**136**	

CONTROL GROUPS	TITLE	SAMPLE SIZE	SEMESTER
MATH 104	Calculus 2	~ 250	Spring 2013, 2014,2015, Fall 2014

Data was cleaned involving the removal of blank records. Data was exported to SPSS where quantitative statistical analysis were conducted to determine whether findings were statistically significant and to find the associations between different items of the survey, when different items of the survey were cross-tabulated with the item which pertains to the overall satisfaction of students learning experience while using the proposed technology. A dedicated team along with instructional and technical staff in the Mathematics department at the America University of Sharjah, UAE worked on delivering the subject for the experimental groups. All recorded lectures presented the same experience as in the class. Students were able to see the notes as well as listen to the high quality audio attached to each slide. An example of what students were able to download and listen to is depicted in Figure 1.



(a) (b)

Figure 1. Snapshot of student view of delivered lecture notes on (A) Math 101 And (B) Math 104 respectively

Results and Findings

Students largely perceived proposed method to be useful in aiding understanding and learning, both during the course and in preparation for assessment. It particularly helped the students understand lectures and revise content at their own pace. On-line lectures helped students become familiar with the program's websites and web resources and provided an opportunity to practice note-taking. This innovative video lecture was regarded as a more effective use of time than face-to-face lectures. More specifically, the following results were collected.

A. Reasons Behind Using the Video Lectures

From the data collected from the survey at the end of the semester for Math 101 and after the midterm exam for math 104, 100% of Math 101 and 66% of Math 104 students indicated that they have watched or downloaded the video lectures at least once per week during the semester. For those who answered yes, the reasons behind that was spread between: being absent, helping in better understanding and to review for quizzes or major exams. Completing class notes was more dominant in Calculus compared to Mathematics for Business and the reasons behind that is related to the fact that calculus requires technical note taking and the time during lectures might not be sufficient to complete all note taking. The results for both experimental subjects are shown in Figure 2 and 3.

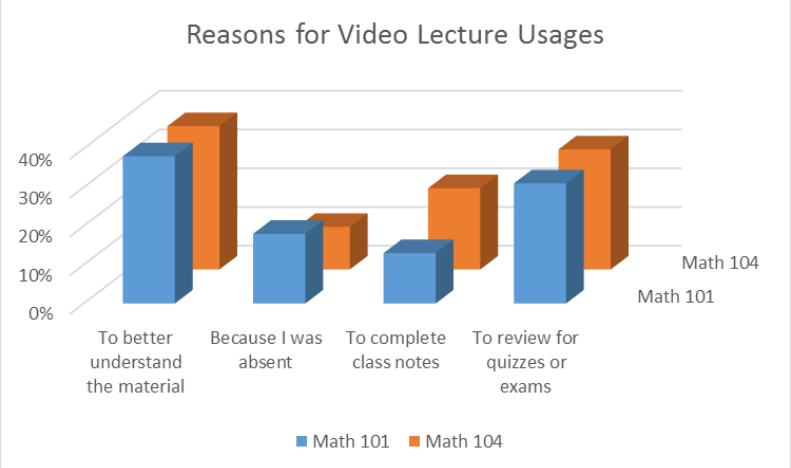


Figure 2. Reasons for using video lectures in mathematics for business and Calculus 2 respectively

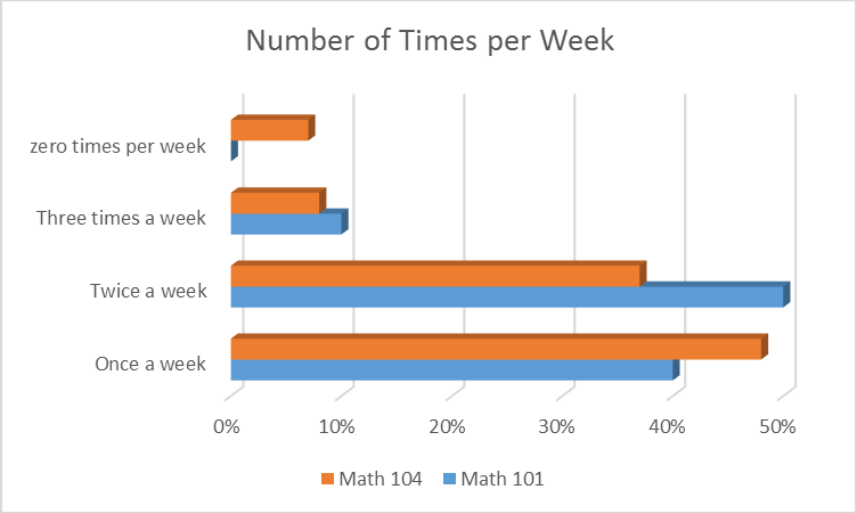


Figure 3. Number of times per week video lectures were accessed

A. Qualitative Data Collected from Survey

Several parts from the survey requested from the students to explain their answers and what they saw positives or negatives about the use of the lecture capture technology.

Usefulness: Most students agreed that the technology was very useful and one student mentioned that: "*They helped if we missed an explanation or need it... They give immediate explanation to doubts, and are a nice way to review for the exams as everything important is mentioned in the videos*" Another student explained that: "*It helps people who work at a slower pace… because after a period of time you might forget the material so it helps you remember. They reinforce the thought explained in class*."

Impact on Understanding: Regarding the impact on course understanding, most students agreed that using the video lectures has a very positive impact on their understanding of the material and one comment was; "*They cleaned up some information which I found confusing at first...*" Another student mentioned: "*I felt I needed a recap.... They helped me revise my understanding and highlight the important tricks...*"Another comment was: "*It's good because they give a second explanation. They allowed me to solve the questions alone and have explanation if I got the answer wrong"*

Impact on Grade: Most students believed the technology affected their grades positively.One comment was: *"it impacted me a lot, my midterm 2 grades improved after watching the videos"* Another comment was: *"It explained some steps that were forgotten and I remembered by watching the videos. They are comprehensive." One notable comment was also: "I failed exam 1 because I didn't watch the videos and got a passing grade for exam 2 because I watched the videos… solving the examples in the videos was a good practice...Small details are being explained…"*

Major Features: When asked about what major features that they liked about the technology, some interesting comments from the students were:

"They explain the material thoroughly.
That was easier to focus, since you can pause and replay until you understand the concept
They are simple and easy to understand
It was like being in class, but you got to repeat it
They are clear and contain all the exact material. They were like a normal class
It is like attending a class all over again."

A. Quantitative Data Collected from Survey

In this section, we use the control group of more than four hundred students to analyze the effects of the introduced lecture capture technology on the experimental group enrolled in Calculus 2 in spring 2017 after the midterm exam results were collected. Table 2 summarizes the data collected on midterm performance for the different groups:

Table 2. Summary of exam grades

SEMESTER	NUMBER OF STUDENTS	MIDTERM AVERAGE	STANDARD DEVIATION
SPRING 2013	32	68%	20.1923077
SPRING 2014	66	66%	19.2857143
FALL 2014	46	68%	18.5714286
SPRING 2015	58	71%	20
SPRING 2017	66	79%	17.3333333

As shown in Figure 4, there is a very notable increase in performance after lecture capture technology was introduced in Spring 2017 compared to other semesters without using such technology. All the students took these courses exactly at the same time during their study and were taught by the same instructor, with the same books, and in the same format. Grade-point average (GPA) and number of course credits should be compared for the groups at the time of graduation in future studies. There was no statistical difference between the groups, suggesting that the groups were very similar in background and ability prior to the Calculus course.

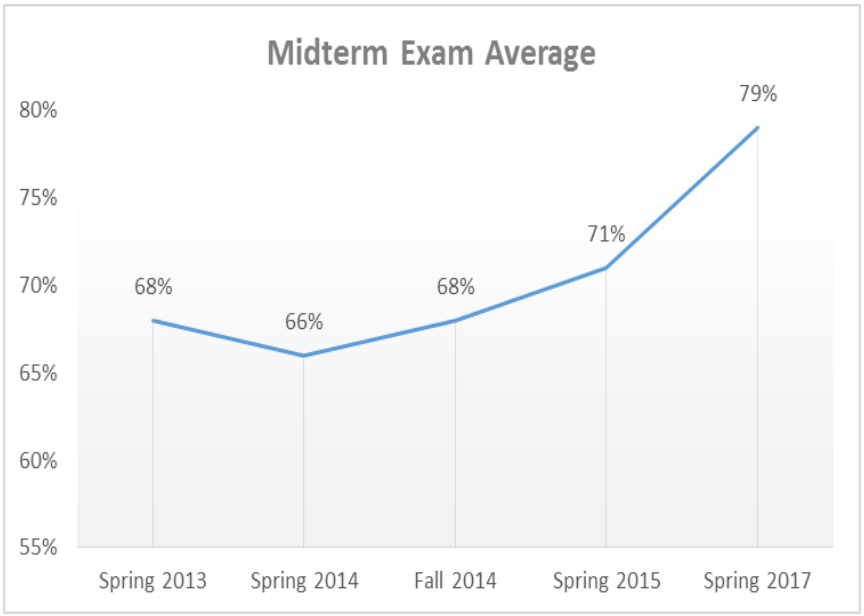


Figure 4. Performance results in midterm 1 in four semesters without using technology compared to Spring 2017 where lecture capture was used

Preforming a one-way ANOVA test results in the following summary data:

	SS	df	MS	F	p
Between:	6,571.164	4	1,642.791	4.695	0.001
Within:	92,030.000	263	349.924		
Total:	98,601.164	267			

At 95% confidence level, we have sufficient evidence to prove that there is a major difference in the means and using technology in spring 2017 resulted in notable increase in exam performance.

A. Teacher Evaluations

Another analysis that were collected is teacher evaluations conducted at the end of the semester. The results are useful to compare the Instructors performance compared to the mathematics department faculty and also to the university as a whole. As can be seen in Table 3 and Figure 5, the instructor results were very positive and the subject evaluations were considerably higher than the rest of the department and also the university. Analysis of the same instructors' evaluations over previous semesters where technology of lecture capture was not used showed notable increase when technology was used in teacher's evaluation.

Table 3. Teacher evaluations

CAS - Course & Faculty Course Experience		Audi, Diana M										--- Survey Comparisons ---					
		Responses					Individual					MTH			All		
		SA	A	N	D	SD	N	Mean	Med.	Mode	Std Dev	N	Mean	Pct Rnk	N	Mean	Pct Rnk
Q1	The course was well organised	18	9	0	1	0	28	4.57	5	5	.68	2.5K	4.20	84	11K	4.27	76
Q2	The course objectives were carefully and clearly defined	17	9	1	1	0	28	4.50	5	5	.73	2.5K	4.19	79	11K	4.29	70
Q3	The course grading scheme was clearly defined	19	5	2	2	0	28	4.46	5	5	.91	2.5K	4.22	79	11K	4.29	71
Q4	The textbook(s) and supplemented material were useful to your understanding of the course content	11	11	4	1	1	28	4.07	4	4,5	1	2.5K	3.94	66	11K	4.00	57
Q5	The assignments and reading material were helpful in improving your understanding of the subject	13	10	4	1	0	28	4.25	4	5	.83	2.5K	4.01	68	11K	4.12	61
Q6	The classroom interaction helped you learn and understand the material	16	8	1	3	0	28	4.32	5	5	.97	2.5K	3.99	76	11K	4.18	55
Q7	The course made you want to learn more about the subject	10	8	8	1	1	28	3.89	4	5	1.05	2.5K	3.70	61	11K	3.94	42
Q8	The course was demanding compared to other courses	14	8	3	3	0	28	4.18	4.5	5	1	2.5K	3.90	81	11K	3.90	76
Q9	The course had high standards compared to other courses	12	9	5	2	0	28	4.11	4	5	.94	2.5K	3.91	65	11K	3.94	64
Q10	The course objectives were accomplished	12	14	2	0	0	28	4.36	4	4	.61	2.5K	4.11	76	11K	4.21	65
Q11	Overall, this course was excellent	10	13	4	1	0	28	4.14	4	4	.79	2.5K	3.90	63	11K	4.05	53

Responses: [SA] Strongly Agree=5 [A] Agree=4 [N] Neutral=3 [D] Disagree=2 [SD] Strongly Disagree=1
Pct Rnk: Percentile Rank (100 is best, calculated vs. precise Mean)

CAS - Course & Faculty Course Instructor		Audi, Diana M										--- Survey Comparisons ---					
		Responses					Individual					MTH			All		
		SA	A	N	D	SD	N	Mean	Med.	Mode	Std Dev	N	Mean	Pct Rnk	N	Mean	Pct Rnk
Q12	The instructor started and finished the class on time	19	8	1	0	0	28	4.64	5	5	.55	2.5K	4.40	75	11K	4.46	68
Q13	The instructor was ready to answer your questions	16	8	3	1	0	28	4.39	5	5	.82	2.5K	4.35	45	11K	4.48	29
Q14	The instructor evaluated your work fairly	16	7	5	0	0	28	4.39	5	5	.77	2.5K	4.24	61	11K	4.28	58
Q15	The instructor evaluated your work on time	10	11	6	1	0	28	4.07	4	4	.84	2.5K	4.29	23	11K	4.32	20
Q16	The instructor's comments on your work were clear, specific and helpful	12	9	7	0	0	28	4.18	4	5	.80	2.5K	4.05	53	11K	4.19	41
Q17	The instructor was very effective in helping you understand the course material	16	10	1	1	0	28	4.46	5	5	.73	2.5K	4.04	73	11K	4.23	64
Q18	The instructor demonstrated a thorough knowledge of the subject	19	7	1	1	0	28	4.57	5	5	.73	2.5K	4.25	74	11K	4.40	64
Q19	Overall, the instructor was excellent	15	11	1	1	0	28	4.43	5	5	.73	2.5K	4.08	66	11K	4.26	57

Responses: [SA] Strongly Agree=5 [A] Agree=4 [N] Neutral=3 [D] Disagree=2 [SD] Strongly Disagree=1
Pct Rnk: Percentile Rank (100 is best, calculated vs. precise Mean)

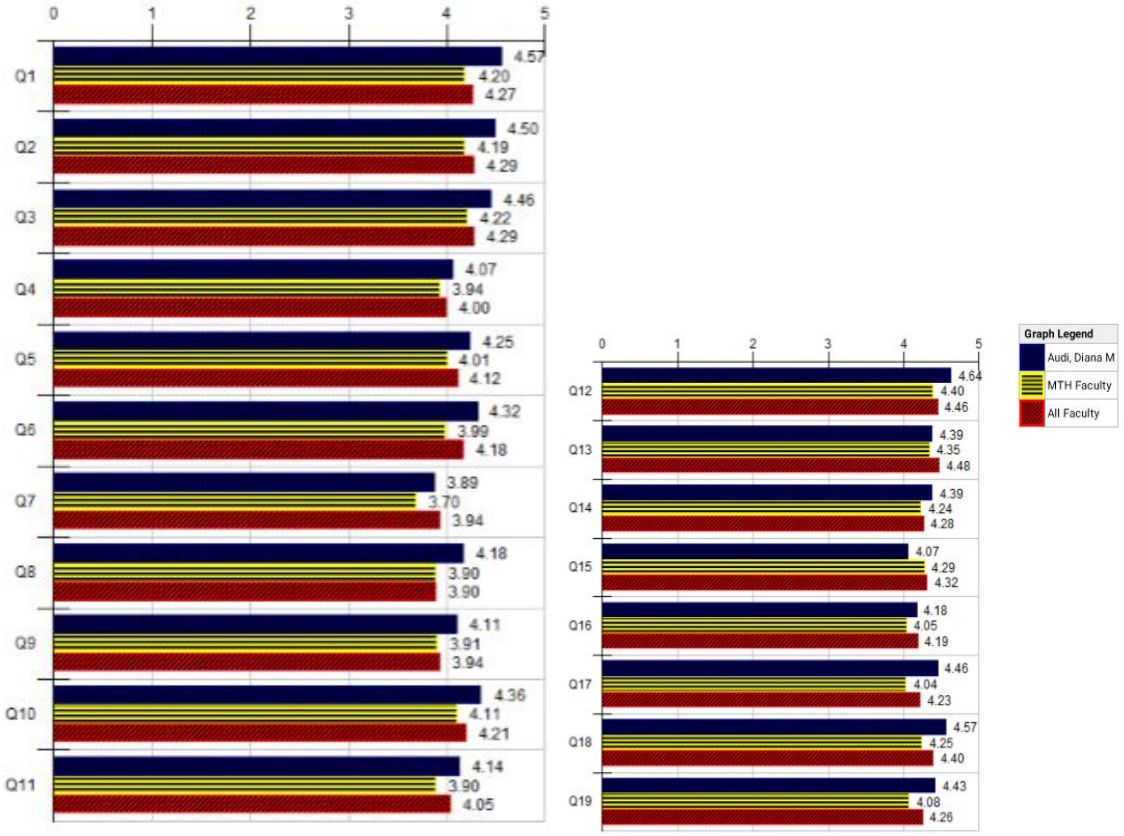


Figure 5. Teacher evaluations for math101 with the usage of technology

Conclusion

In this paper, the concept of introducing rich text format lecture capture technology in Mathematics subjects (Math for Business and Calculus 2) was rigorously analyzed. Both control groups without using any form of technology and experimental groups with using the proposed technology were compared in terms of student acceptance and academic performance improvements. Both qualitative and quantitative analysis were used and the results are very promising. Students saw the added benefits and found the technology very useful. Exam performance was compared and using the technology showed positive improvements over previous semesters.

References

Craig, P. et al. (2009). Student use of web based lecture technologies in blended learning: Do these reflect study patterns? In Same places different spaces. Proceedings ascilite Auckland 2009. pp. 158–167.

Gorissen, P., Van Bruggen, J. &Jochems, W. (2012). Students and recorded lectures: survey on current use and demands for higher education. Research in Learning Technology, 20, pp.143– 153.

Gosper, M. et al. (2008). Final Report: The Impact of Web-Based Lecture Technologies on Current and Future Practices in Learning and Teaching, Sydney: Australian Learning and Teaching Council.

Holbrook, J. &Dupont, C. (2009). Profcasts and Class Attendance – Does Year in Program Matter? Bioscience Education, 13(June). Available at: www.bioscience.heacademy.ac.uk/journal/vol13/beej-13-c2.pdf.

Inglis, M. et al. (2011). Individual differences in students' use of optional learning resources. Journal of Computer Assisted Learning, 27(6), pp.490–502.

Leadbeater, W. et al. (2013). Evaluating the use and impact of lecture recording in undergraduates: Evidence for distinct approaches by different groups of students. Computers Education, 61, pp.185–192.

Owston, R., Lupshenyuk, D. & Wideman, H. (2011). Lecture capture in large undergraduate classes: Student perceptions and academic performance. The Internet and Higher Education, 14(4), pp.262–268.

Phillips, R. et al. (2011). Learning analytics and study behaviour : A pilot study. In In G. Williams, P. Statham, N. Brown & B. Cleland (Eds.), Changing Demands, Changing Directions. Proceedings ascilite Hobart 2011. pp. 997–1007.

Settle, A., Dettori, L. & Davidson, M.J. (2011). Does lecture capture make a difference for students in traditional classrooms. In Proceedings of the 16th annual joint conference on Innovation and technology in computer science education - ITiCSE 2011. New York City, New York, USA: ACM Press, p. 78.

Soong, S.K.A., Chan, L.K. & Cheers, C. (2006). Impact of video recorded lectures among students. In Proceedings of the 23rd annual ascilite conference: Who's learning? Whose technology? Ascilite 2006. Sydney, The University of Sydney. Sydney, pp. 789–793.

Traphagan, T., Kucsera, J. V &Kishi, K. (2009). Impact of class lecture webcasting on attendance and learning. Educational Technology Research & Development, 58(1), pp.19–37.

Van Zanten, R., Somogyi, S. & Curro, G. (2012). Purpose and preference in educational podcasting. British Journal of Educational Technology, 43(1), pp.130–138.

Von Konsky, B.R., Ivins, J. & Gribble, S.J. (2009). Lecture attendance and web based lecture technologies : A comparison of student perceptions and usage patterns. Australasian Journal of Educational Technology, 25(4), pp.581–595.

Woo, K. et al. (2008). Web-based lecture technologies: blurring the boundaries between face-to-face and distance learning. Alt-J, Research in Learning Technology, 16(2), pp.81–93.

Williams, J. &Fardon, M. (2007). Lecture recordings: extending access for students with disabilities. In Research paper for ALT-C: Beyond Control 2007, University of Nottingham. Nottingham.

Williams, J. (2006). The Lectopia service and students with disabilities. In Proceedings of the 23rd annual ascilite conference: Who's learning? Whose technology? Ascilite 2006. The University of Sydney. Sydney, pp. 881–884.