Full Paper

Introduction

With the increasing technological development, most higher education institutions and corporations are offering more lectures, seminars, and classes to teach and train students and employees using new technologies (Liu et al., 2001). At present, most universities use online flexible learning management system such as Blackboard that supports the online delivery and administration of resources, communication, collaboration and assessment. Most students also strongly believed that the recorded lectures are useful and they think that the lectures should be recorded and made available online (Pale et al., 2014; Leadbeater, et al., 2013; Williams et al., 2012; Beale et al., 2014). Often students consider lecture capture as a useful learning tool (Karnad 2013) which allows them greater flexibility to manage other commitments, such as work and family life (Cooner 2010). Students with physical or learning disabilities may find recorded lectures particularly useful. For example, this may be an alternative way to manage the pressure of note-taking in class, or managing their disabilities in regards to attending lectures (Williams 2006).

One of the main objectives of online delivery of a face-to-face unit is to embed iLecture in the learning management system. The iLectures contain the audio and the PowerPoint which enable students to learn in a mobile environment and combine working part-time with university study. The iLecture system has audio-visual recording and live webcasting capabilities that are suitable for capturing live lectures, seminars, student practicals and assignments, oral and prac exams and for the preparation of pre-recorded teaching material (Curtin University, 2015). The iLectures can be automatically published online in the flexible learning management system- Blackboard that provides flexible learning opportunities for the users. That means, students can view it from anywehere anytime fulfilling their other commitments and needs.

But the traditional iLectures do not capture physical demonstration of lecturer and thus students face difficuties in revision. Lecturing engineering units needs varieties of practical demonstrations with examples. Sometimes it needs complicated mathematical derivation and its proper explanation and physical application of the derived mathematics. Lecture materials prepared in PowerPoint are not enough for clear understandings of all engineering concepts. Different lecturers use different mode of concept demonstration such as, blackboard-chalk, whiteboard-marker or tablet PC. Blackboard-chalk or whiteboard-marker could not be integrated in traditional iLecture system because it is not digitized. Thus student found lot of difficulties while revising the materials. This is because they could listen to the lecturer's voice only and could not see his hand writing or sketching about what he is discussing. Students feel comfortable while attending lecture physically to understand the lecturer's demonstrations using any mode together with PowerPoint slide but weaker students and students with disabilities and illness face difficulties when they start to study for exam using iLectures. They cannot find anything written on whiteboard in iLecture. They can only listen to the lecturer's voice which does not always correspond to the PowerPoint slides that they see in iLecture.

Document camera is another device that can be used in the lecture theatres. The hand written items on the paper captured in document camera may be seen in iLecture but losing the PowerPoint. Next, Tablet PC can be used in the lecture which is a versatile

computer system that can have the computing power of a laptop or desktop computer along with a digitized pen for enhanced functionality such as handwriting recognition, freehand drawing, and the ability to annotate documents with digital ink. Pen-enabled software such as the MS Office Suite, MS Windows Journal, and MS One Note provide a robust electronic solution for taking or delivering notes. A tablet PC or document camera may capture the hand-writing demonstration (Derting and Cox, 2008) but in both cases, it looses the PowerPoint. This causes problem of having only one in the screen while both are needed at the same time for better demonstration of engineering concepts. In order to solve these issues, an auto- tracking camera (known as iSmart video camera) may be used in the lecture theatre that captures white board demonstration and at the same time it embeds with the PowerPoint in iLecture using Echo360. Thus the objective of this paper is to investigate how an auto- tracking camera affects student learning using iLectures in an engineering unit**.**

iLecture and iSmart video camera at Curtin University

iLecture system (run by Echo360) is used by most universities and higher education institutions for recording the physical lectures and make them available online to their users. The iLecture system at Curtin university captures up to 300 or more recordings per day during semester with over 30,000 recordings captured each year and heading towards 3 million recordings streamed and downloaded annually (Curtin website 2015). Of this, two- thirds of recordings are scheduled recordings captured automatically in one of the 150+ iLecture-equipped venues across all campuses of Curtin University. The iLecture media player ("EchoPlayer") requires Adobe Flash v9 or higher (Student guide 2015). Therefore it is only possible to access the EchoPlayer on platforms that supports Adobe Flash. Media files downloaded from the Echocenter can be played back using variety of common media players that are available for each operating systems including Android.

In 2014, approximately 70 iSmart auto-tracking video cameras were installed in the first semester of 2014 in lecture theatres and rooms across the Bentley campus of Curtin University. Among them, 40 major teaching venues are automatically recorded and made available to students in the corresponding Blackboard units. These cameras capture full- motion video and automatically pan, tilt and zoom to follow the presenter as they move around the front of the venue. The recorded video alongside the recording from the presentation computer is then made available in Curtin's existing Echo360 iLecture system. The recording of multiple whiteboard demonstrations are also now possible using this technology. The iSmart video recordings are embedded with the PowerPoints slide in iLectures and the students can get all information delivered in the lecture theaters.

Methodology

In order to investigate the effect of auto-tracking camera on student learning, a 3rd year Civil Engineering core unit (Water Engineering 361) at Curtin University is chosen. The unit consists of pumps and open channel hydraulics. The unit learning pattern consists of lecture/tutorial and two laboratories- one for pump and one for open channel hydraulics. The lectures are delivered in an iLectured enabled lecture theatres. Each lecture consists of theoretical description followed by practical examples of different real field situations. This provides practice based learning outcomes of this unit. Until 2013, the iLecture recorded audio and PowerPoint. But most explanation and demonstrations were done by white board

and marker. Students' online feedback on this unit showed that the iLecture does not

provide adequate information because it did not capture white board demonstration and was hard for revision. In 2014, the venue for this unit was equipped with iSmart video camera (an auto- tracking camera) and iLecture was recorded capturing the whiteboard demonstration.

In this study, the iLecture view data was collected from Curtin University's iLecture Echocenter for 2013 and 2014 respectively. The same lecture theatre was used for both 2013 and 2014 respectively - one without iSmart camera and one with iSmart camera installed. Student engagement data for both years was collected from the student aggregate report generated in Echocentre. The iLecture view data for individual student was obtained in different categories: (i) Unique Views- This parameter is the number of different Echoes the student has viewed. (ii) Cumulative Views- This parameter is the total number of Echoes the student has viewed. (iii) Completion- This parameter is the amount of Echo that was viewed. A student who watches every scene of an Echo generates a completion rate of 100% for that Echo. This parameter is the average completion rate for all Echoes viewed. In general, a higher number of these views indicate higher student engagement (Curtin University, 2015). However, there were also other information in the student aggregate report but those were not used in this study.

Next, a questionnaire survey was conducted among the students who went through both the systems of iLecture with and without iSmart camera. The Q1-Q8 stands for positive feedback and Q9 is for negative feedback on iSmart camera. The questions include: *(1) I find iLectures with video recording helping me in preparing for exam (2) This new iLecture is excellent for revision, (3) This iLecture provides face-to-face learning experiences using online resources*
(4) Capturing whiteboard demonstration in iLecture through auto-tracking camera provides better understandings when listening to iLectures. (5) Accessing anytime from anywhere to iLecture provides more flexible learning opportunities (6) I can attend other commitments but still this iLecture helps me to get same learning outcomes (7) Video recorded with PowerPoint-audio iLecture provides better learning opportunities than PowerPoint-audio iLecture only. (8) Overall. I am satisfied with new video recorded iLecture with PowerPoint and audio system and (9) Camera does not focus all time on lecturer and I do not get everything in iLectures. The student feedback on each questions was similar to Curtin's online student feedback system-eVALUate e.g., *(i) Strongly Agree (ii) Agree (iii) Disagree (iv) Strongly Disagree (v) Unable to Judge*.

Finally, the student performance of both 2013 and 2014 was analysed and compared with the data obtained from iLecture student aggregate report and questionnaire survey to check the influence of auto tacking camera on student learning on Water Engineering 361.

Results and Discussion

Student engagement in iLectures

The student engagement data was extracted for individual student from Echocenter for the unit-Water Engineering 361 for 2013-2014. The 2013 iLecture was recorded when there was no iSmart video camera in the venue and 2014 iLecture was recorded with iSmart video camera. The unique view, cumulative view and average completion views of iLectures of individual student for both years were extracted from Echocenter and arranged in ascending order which is shown in Figure. 1. Approximately 150 students were

enrolled in Water

Engineering 361 unit for both years (2013-14) at Bentley campus of Curtin University. This unit is also simultaneously offered in Curtin's offshore campus at Sarawak, Malaysia. But in this study, only the iLecture data of individual student enrolled at Bentley campus was used for analysis. The result shows that the iLecture view data decreases exponentially with the number of students. That means fewer number of students viewed the iLectures for repeated number of times. But the number of views has significantly increased in 2014 when the iSmart camera was installed. This clearly shows that the students feel more meaningful to view the iLectures when the whiteboard demonstrations are incorporated in iLectures. The highest average completion of iLecture views increased from 42 to 67 percent when iSmart camera is embedded in iLecture recordings.

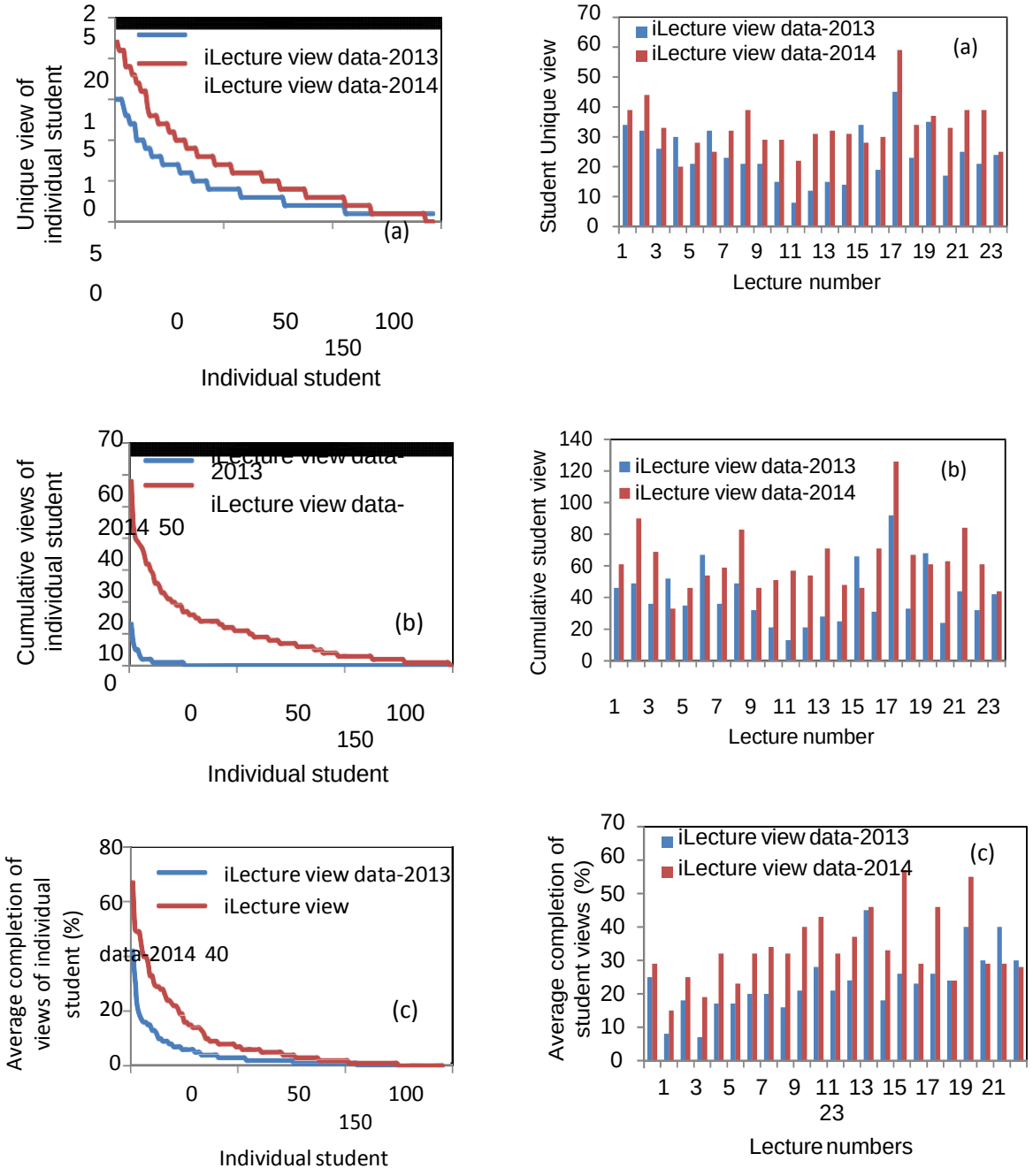

Figure 1. Student view of iLectures for Water Engineering 361 in 2013-2014 (a) Unique student view (b) Cumulative student view (c) Average completion of student view

Figure 2. iLecture student view for different lectures of Water Engineering 361 in 2013- 2014 (a) Unique student view (b) Cumulative student view (c) Average completion of student view

There are total of 24 lectures scheduled in this unit in 12 weeks. But mid-semester exam is taken in week 7 using one 2hr lecture slot. Thus 23 iLectures are available in Echocenter for

students to view. The mid-semester exam is on pump hydraulics section and the final exam is on open channel hydraulics. Ten students in a group performed two labs in the semester and the lab reports are required to submit after two weeks of lab session. These influence the students to view iLectures throughout the semester. The number of unique views, cumulative views and average completion for each lecture was extracted from the Echocenter for 2013-2014 respectively for this unit and shown in Figure 2. The results revealed that the students were more motivated to listen and watch the iLectures when iSmart camera data is added in iLectures. The number of views in each lecture has been significantly increased when iSmart camera was installed. Interestingly, the lecture number 17 has the highest number of views which covers the complicated mathematical application of open channel hydraulics in civil engineering. The maximum unique views increased from 45 (2013) to 59 (2014) and the average completion increased from 45 (2013) to 59 (2014) respectively. The minimum views data has also been increased. For example, minimum views data for unique views increased from 8 (2013) to 20 (2014) and the minimum average completion data increased from 7 (2013) to 15 (2014). The average completion data is the amount of Echo that was viewed. As given earlier, a higher number indicates higher engagement. That means the students were more engaged in learning when the iSmart video camera was installed and the video data was attached in iLectures.

Student feedback on iSmart video camera

A total of nine questions were asked in the questionnaires. Question number one to eight indicates how iSmart camera helps student learning and engagement. Question nine indicates whether video recorded iLectures have any influence on the non-attendance of the physical lectures. The anonymous paper-based survey data (n=23) was collected in the last lecture of the semester and all agreements and disagreements to each question are plotted and shown in Figure 3. The lower number of participants was found because of the lower number of attendance in the last week. Usually last week attendance is fewer because of students' extra workload for assignment submission of other units. This trend has been noticed for last couple of years even when the iSmart camera was not there. However, the percentage of agreement varied between 42-95. The least percentage agreement (42%) was found for question 3-"*This iLecture provides face-to-face learning experiences using online resources*". But the disagreement to this item is 35%. This indicates that the face-to-face learning cannot be substituted completely with online resources even all lecture information is provided in iLectures. The main reason for this is that the student has no option to ask questions to the lecturer. The iLecture may be very good resource for revision but may not be the only option for learning without attending the physical lecture.

However, the highest agreement was found for question 5-*"Accessing anytime from anywhere to iLecture provides more flexible learning opportunities*". There was no disagreement to this item and this indicates that the current iLecture systems provide most flexible learning opportunities. The overall student satisfaction was found 69 which indicate that still there are some limitations for iSmart camera recording systems. For example, the iSmart video camera focuses to any moving object in front. If anybody enters or goes out from the venue during the lecture, it focuses to them and whiteboard disappears in iLectures. This was also found in the agreement (69%) of question 9-

“*Camera does not focus all time on lecturer and I do not get everything in iLectures*”. As this is a relatively new technology,

there are still some issues with camera resolution and focus appropriateness that needs to be addressed.

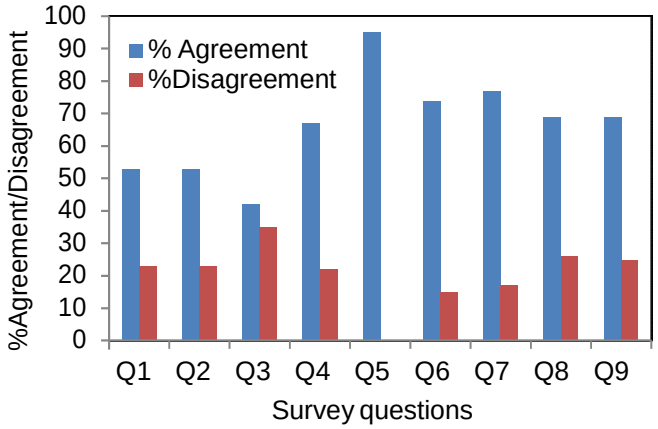

Figure 3. Student feedback on the use of iSmart camera in iLecture

The effect of iSmart video camera on student performance

The above results clearly shows that the students were more motivated and inspired to view iLectures when the iSmart camera was installed and embeded in iLectures. The student performance data on this unit (Water Engineering 361) was anlaysed for 2013-pre auto tracking camera and 2014-post auto tracking camera. The number of students (%) and their grades were plotted in a histogram and shown in Figure 4. The student performance data revealed that the percentage of student getting >80% marks has increased from 24 to 66 and average mark increased from 69 to 82 when auto-tracking camera was introduced for this unit. This is because it provides multiple delivery modes and access to physical lecture that is more useful for revison to support students. It has also been reported that many students found video recorded lectures as a useful learning tool because they can use it to catch up the missed lectures and also as a revision tool for exams and assessments (Karnad, 2013).

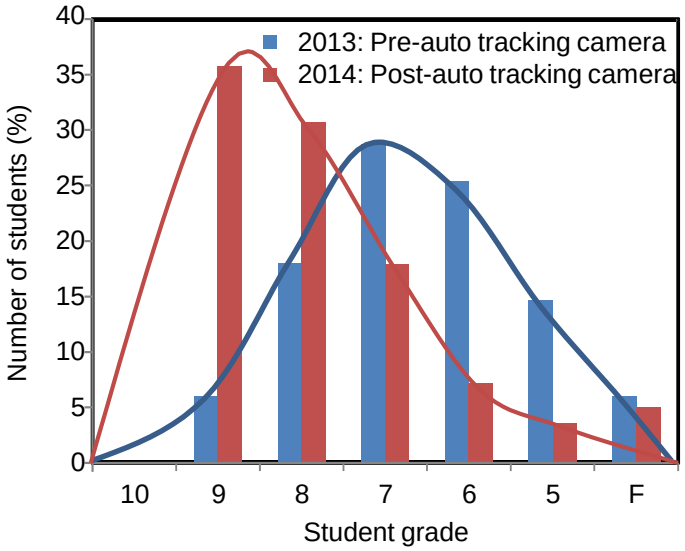

Figure 4. Student performance for the unit –Water Engineering 361 in 2013-2014

Conclusion

The effect of auto-tracking camera (iSmart video camera) in iLectures was investigated for a civil engineering unit at Curtin University. The iLectures view data for two consecutive years (one with pre-auto tracking and one with post-auto tracking camera) were extracted from Echocenter and the numbers of student views were analysed. A questionnaire survey was conducted to get the student feedback on the use of auto-tracking camera in iLecture for student learning. These data was used to check whether auto-tracking camera has any effect on the overall student learning. The results showed that the number of iLecture views increased significantly when auto-tracking camera was introduced. The survey results of 77% of agreement indicate that the iLectures with iSmart camera recording provides better learning opportunities than PowerPoint-audio iLecture only. Because of improved iLecture systems, the overall student performance was also improved. Though it is a very useful tool for student engagement especially when students are out of class but it needs further development in terms of resolution and not capturing other moving elements. The students should consider it as a supplement to the original lecture only otherwise it may affect the lecture attendance.

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Acknowledgements

The author gratefully acknowledges the help provided by the iLecture support team of Curtin University to extract iLecture view data.

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