Development of video-based collaborative lecture delivery and quiz scoring management mechanism for high student-to-staff ratio classes

Queenta Edem Akpan[1]

Department Of Electrical/Electronic And Computer Engineering, University of Uyo, Akwa Ibom State Nigeria

Ozuomba Simeon[2]

Department Of Electrical/Electronic And Computer Engineering, University of Uyo, Akwa Ibom State Nigeria
simeonoz@yahoo.com
simeonozuomba@uniuyo.edu.ng

Bliss Utibeabasi Stephen[3]

Department Of Electrical/Electronic And Computer Engineering, University of Uyo, Akwa Ibom State Nigeria

***Abstract*—In this paper, the development of video-based collaborative lecture delivery and quiz scoring management mechanism for high student-to-staff ratio classes is presented. The presented mechanisms are web based and incorporated functionalities for managing the registration of users, the delivery of video-based lecture and assessment modules. The web app also included functionalities for managing the submission of the assessment answers e-scripts from the students, along with collaborative mechanism for using the students to effectively mark the e-scripts. This approach can enable the course lecturer to mark the script of large classes of any size in time frame that is less than marking about five students' scripts. The paper also presented video frame tagging and numbering mechanism which enables the lecturer to tag every segment of the video learning content and enables the video content user to quickly and precisely refer and access any point in the video content. The mechanism requires some analytical computations and the relevant analytical expression are developed and presented along with the some numerical examples. The ideas presented in this paper will help lecturers engaged in large classes to effectively deliver their lectures and conduct assessment of the students with ease. The ideas will also enhance the use of video-based learning contents.**

Keywords*— *E-Learning, Web Application, Video-Based Collaborative Lecture, Quiz Scoring Management Mechanism, Student-To-Staff Ratio, Timer-Based Frame Numbering Scheme, Lecture Timetable

1. INTRODUCTION

Over the years, in many developing countries, there has been the challenge of large student-to-staff ratio (StTR) in educational institutions [1,2,3,4,5,6,7,8,9,10]. Also, the use of e-learning and Open University learning approach attracts large number of students because of the ease of learning from the comfort of their homes and offices [11,12, 13,14, 15,16, 17,18, 19,20, 21,22, 23]. However, delivering quiz and marking of the answer booklets for large number of students can take substantial amount of time of the course lecturer. Meanwhile, proper learning requires a certain degree of assessment of the students, to ascertain their level of understanding and see areas that require further explanations [24,25,26,27,28,29,30,31,32,33,34,35].

Apart from the assessment challenge associated with large StSR, the learning contents are easily delivered using video contents [36,36,37,38,40,41,42,43,44,45,46,47,48,49]. However, unlike the paper based lectures that every content can be referenced using pages, paragraphs and lines on a page, the video content is difficult to reference. As such, there is need for ways to tag the various segments or various sections of a video content so as to facilitate easy referencing of the contents.

Accordingly, in this paper, the mechanism for tagging and tracking any point in video contents is developed. Also, the use of mechanism for using the students to collaboratively mark the students' e-answer booklets is presented in this paper. The collaborative marking mechanism help the course lecturer to spend less time in marking the answer booklets of the large class. Instead, the lecturer uses the students to mark the students' scripts in such a way that the overall time taken for the marking exercise is less than the time taken to mark about five scripts in all. In essence, irrespective of the number of students in the class, the collative e-answer booklet marking mechanism will enable the lecturer to effectively conclude the marking in timeframe required to mark not more than five scripts. The ideas presented in this paper while solving the immediate problems also opens up numerous research questions as regards the viability, scalability and limitations of such

mechanisms. Hence, further studies are required to attend to the research questions emanating from this paper.

2. METHODOLOGY

The mechanism is focused on enabling a lecturer to manage large number of students in a class. The mechanisms used video-based lecture suites and quiz management system to enable the lecturer to deliver the lectures and issue quiz per lecture and then use the students to score the quiz and generate the total score. Some quality assurance mechanisms are included in the quiz management mechanism. The two sections of the mechanism are the lecture mechanism and the collaborative quiz assessment mechanism.

2.1 DEVELOPMENT OF THE LECTURE MECHANISM

The main activities carried out in the lecture mechanism development includes:

i. Breakdown and sequence the lecture content
ii. Preparation of the lecture suite materials (videos and printer ready transcripts) with collaborative quiz management numbering scheme and timer-based frame numbering scheme
iii. Upload lecture timetable and lecture suite
iv. Deliver lecture and update video

2.1.1 Breakdown and sequencing of the lecture material

Here, lecture materials are broken down and sequenced on weekly basis. The course contents for each week is again broken down into different topics, which together make up the topic suite for the week. Similarly, each topic is further broken down into different sub-topics that can be delivered with one set of lecture suite, where each lecture suite has about four different components, namely, the lecture video/slide, the individual quiz pack, the group work pack and the practice questions pack. The details of the architecture for the course material breakdown and delivery framework is shown in Figure 1. The concept of suite adapted in this work is adapted from software suite which can be defined as two or more programs or software which are bundled together to offer a complete solution that covers different aspects of the users' needs. Similar concept is used to describe topic suite and lecture suite. In this case a topic suite consists of two or more topics which together covers a given section of the course outline meant (in this case) for a given lecture week. The lecture suite consists of a bundle of components that together are used to deliver lecture for a given topic and to assess the students and provide practice questions in respect of the topic.

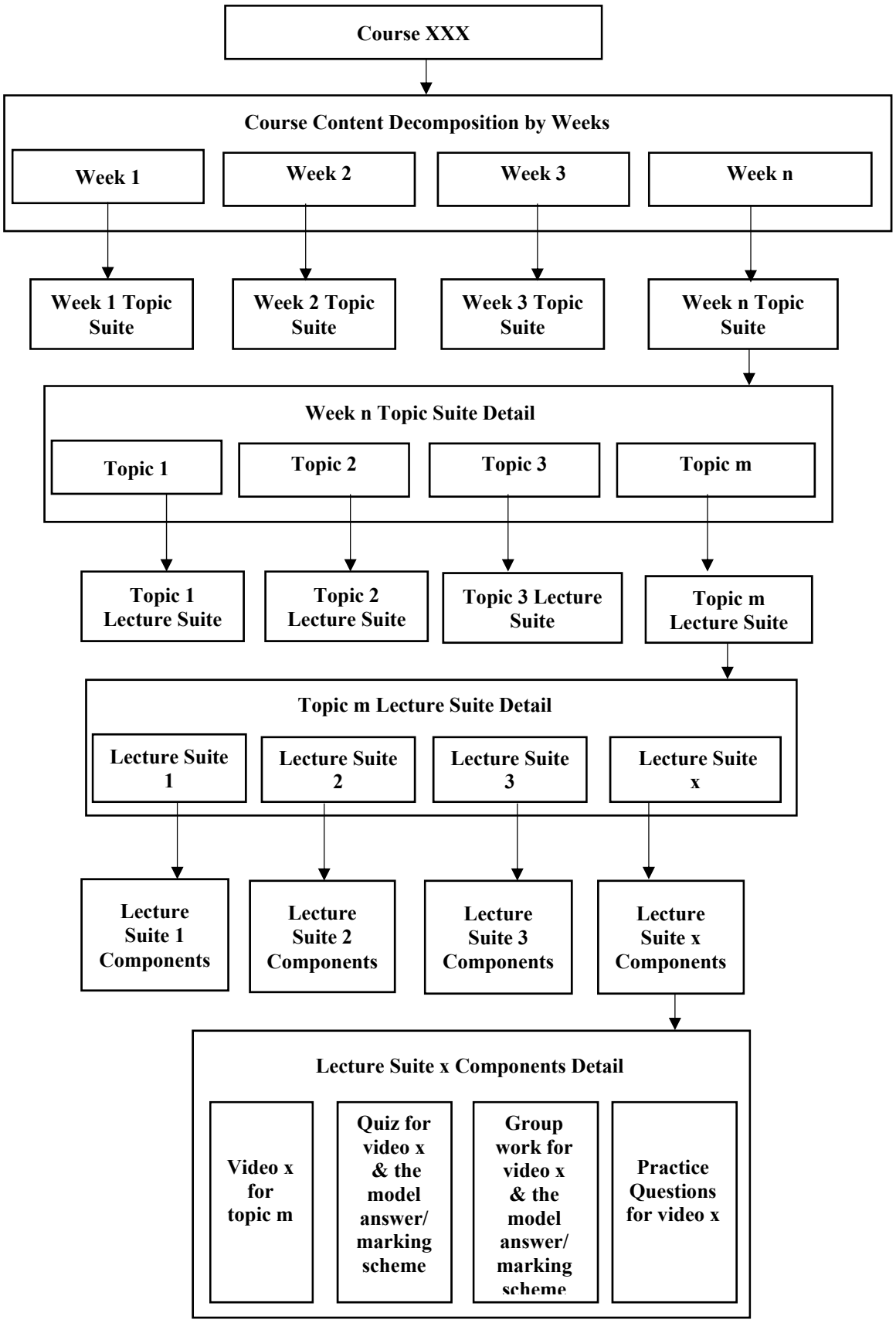

Figure 1 The architecture for the course material breakdown and delivery

2.1.2 Preparation of the Lecture Suite Materials (Videos and Printer Ready Transcripts) with collaborative quiz management numbering scheme

Each lecture suite consists of four different components (Figure 1), namely, the lecture video/slide pack, the individual quiz pack, the group work pack and the practice questions pack. The lecture video and the other lecture suite components are prepared by the course lecturer. Particularly, the lecture video is prepared and delivered ahead of the date and time for the lecture. Each lecture video and its corresponding lecture suite components has its feedback forum wall where students and the lecturer can post their comments for the particular lecture suite. A printer ready version of the detailed lecture note transcript is also prepared. The quiz video is prepare along with a printable or printer ready transcript of the quiz. The video of the marking or scoring guideline for the quiz solution is also prepared as part of the lecture suite. The printable or printer ready transcript of the quiz model answer and marking scheme is also prepared.

In order to hide the identity of students for the collaborative quiz marking framework, an e-answer booklet is created which the student use to do and submit their e-quiz script. The e-answer booklet has field for the student name, registration number, and quiz management number. Each of the three items are automatically filled by the quiz management module.

When the quiz is issued, each student is assigned a quiz distribution number (Qnum). However, when the submitted quiz is distributed for the collaborative marking, the quiz marking distribution number (Mnum) is used to replace Qnum. The Qnum and Mnum are generated and formatted in such way that they are totally different from the student registration number. For the Qnum, the total unique number generated is equal to the total number of students that registered on the online platform for the course. On the other hand, for the Mnum the total unique number generated is equal to the maximum number of students that submitted their quiz solution within the stipulated timeframe, before the quiz portal is locked.

In order to enhance the quality of marking, the quiz can be marked two times. In that case, the Munm is performed two times. In the first case it is M1num and in the second case it is M2num. The script is distributed randomly to different students that submitted their quiz solution and the average score from the two is used. Where the difference between the first and the second score is much, (say more than 30% difference), the quiz score is either reviewed by the course lecturer or a third round of marking is done on the affected scripts and the two closest scores are taken, and the average computed.

Another option is to generate M1num and M2num at the same time and assign two different scripts to each student at the same time. Importantly, the database is used to match Qnum, M1num and M2num with the students' registration numbers. The random allocation of scripts for marking is done in such a way that no student is assigned his own script and the two scripts assigned to a student are not from one student (it must be scripts from different students).

2.1.3 Development of the Timer-Based Frame Numbering Scheme

In order to enhance referencing of the section of the video where comment is being made, a timer-based frame numbering scheme is adopted. In this case, the timer can be set, for example, one frame per minute (60 seconds) with five subdivisions (of 60/5 or 12 seconds per subdivision). This means that every minute (60 seconds) in the video screen play is assigned a different sequential frame number (starting from 0) with subdivision every 12 seconds (60/5 seconds). For instance, the frame number can be 15.3, which is the 15th minute and the 24th to 35th second. In this way, comment on this segment can read, "check video frame 15.3 for explanation on…" The timer-based frame number is indicated boldly on the lower section of the lecture video and it serves as slide number for referencing the various section of the lecture. Sample video frame number generated using the model is presented in Table 1. The model for generating the video frame (slide) number is given as follows:

Set the unit time frame in seconds (UTF)

Set the subunit division (SUD)

Let the video timer count in seconds be denoted as (DTC)

The frame number (FN) is computed as follows:

$$FN_x = \left\lfloor \frac{\text{DTC}}{UTF} \right\rfloor \quad (1)$$

$$SUDTF = \left\lfloor \frac{UTF}{SUD} \right\rfloor \quad (2)$$

$$Q_y = \text{DTC} - \left\lfloor \frac{\text{DTC}}{UTF} \right\rfloor = \text{DTC} - FN_x \quad (3)$$

$$FN_y = \left\lfloor \frac{Q_y}{SUDTF} \right\rfloor = \left\lfloor \frac{\left(\text{DTC} - \left\lfloor \frac{\text{DTC}}{UTF} \right\rfloor\right)}{SUDTF} \right\rfloor = \left\lfloor \frac{(\text{DTC} - FN_x)}{SUDTF} \right\rfloor \quad (4)$$

$$\text{FN} = FN_x . FN_y \quad (6)$$

In the sample video frame number calculation presented in Table 1, the unit time frame (UTF) is 90 seconds or one and half minutes and the subunit division (SUD) is 5. This means that a video screen or frame number lasts for 90 seconds, and the 90 seconds is divided into five divisions or sub-frames of 18 seconds per division. Hence, (as shown in Table 1, serial number 10 or row 11), a video timer count (DTC) counter value of 522 seconds (8 Minutes, 42 Seconds) will give a video frame number (FN) of 5.4. This means the video is in frame number 5 or the fifth frame and within the fifth frame it is currently in the 4th sub-frame, where the maximum sub-frame number is 5.

Table 1 Sample video frame number (FN) generated using the model

S/N	DTC (seconds)	UTF (seconds)	SUD	SUDTF (seconds)	Qy (seconds)	DTC (minutes: Seconds)	FNx	Fny	FN
1	36	90	5	18	36	0 Min :36 Sec	0	2	0. 2
2	90	90	5	18	0	1 Min :30 Sec	1	0	1. 0
3	144	90	5	18	54	2 Min :24 Sec	1	3	1. 3
4	198	90	5	18	18	3 Min :18 Sec	2	1	2. 1
5	252	90	5	18	72	4 Min :12 Sec	2	4	2. 4
6	306	90	5	18	36	5 Min :6 Sec	3	2	3. 2
7	360	90	5	18	0	6 Min:0 Sec	4	0	4. 0
8	414	90	5	18	54	6 Min :54 Sec	4	3	4. 3
9	468	90	5	18	18	7 Min :48 Sec	5	1	5. 1
10	**522**	**90**	**5**	**18**	**72**	**8 Min : 42 Sec**	**5**	**4**	**5. 4**
11	576	90	5	18	36	9 Min :36 Sec	6	2	6. 2
12	630	90	5	18	0	10 Min :30 Sec	7	0	7. 0
13	684	90	5	18	54	11 Min :24 Sec	7	3	7. 3
14	738	90	5	18	18	12 Min :18 Sec	8	1	8. 1
15	792	90	5	18	72	13 Min :12 Sec	8	4	8. 4
16	846	90	5	18	36	14 Min :6 Sec	9	2	9. 2
17	900	90	5	18	0	15 Min:0 Sec	10	0	10. 0
18	954	90	5	18	54	15 Min :54 Sec	10	3	10. 3
19	1008	90	5	18	18	16 Min :48 Sec	11	1	11. 1
20	1062	90	5	18	72	17 Min :42 Sec	11	4	11. 4

2.1.4 Upload Lecture Timetable and Lecture Suite

The lectures are delivered using the lecture suite for each topic or subtopic. So, the timetable is drawn based on the lecture suites. In this case, each week has a number of topics and one or more than one subtopics under each of the topic. Each subtopic is designed such that one lecture suite is used to handle a subtopic. Hence, the timetable indicates the subtopics that will be handled within a given week. A given lecture can accommodate a number of subtopics. The timetable is posted on the course portal for all the stakeholders to access.

After the lecture videos and other lecture suite components are prepared, they are uploaded on the collaborative lecture platform. Note, the model answers and marking schemes are locked and released at appropriate time the particular item is needed.

Importantly, students registered for the course login with their details and access the lecture materials, submit quiz and participate in the collaborative quiz assessment or marking framework.

The platform has provision for comment per course and within a course on can select a specific lecture suite to post comment. A comment on the general class platform will indicate the lecture suite it is referring to, so comments are arranged in respect of the lecture suite they apply.

2.1.5 Deliver Lecture, Release the Quiz and Updated Lecture Videos

During the lecture which can be physical lecture contact or video based, the issues raised by the students in the comment session are addressed and the updated video including the original video and the additional content generated during the class is posted for students to access.

At the end of the class, the individual–based quiz and the group–based quiz are released to the students and the time lines for the submission of the quiz are also stated along with the date and time for the collaborative marking of the quiz. Also, some practice questions related to the concluded topic or subtopic are released to the students.

2.2 DEVELOPMENT OF THE COLLABORATIVE QUIZ ASSESSMENT MECHANISM

The collaborative quiz marking mechanism enables the course lecturer to use the students to mark the scripts. It can be done that at the end of each lecture, the quiz given in the last lecture period is marked with the assistance of the students. In this case, the students that attended the current lecture are assigned the quiz answer booklets and they mark them and thee submit the marked scripts to the online platform. The entire collaborative quiz marking mechanism is captured in the detailed procedure presented in eight (8) steps.

a) Generate questions with explicit detailed model answer and marking scheme for each question

At this stage, the course lecturer generates the quiz questions, the model answers and marking scheme for lecturer subtopic xxx with suite number xxx. The quiz questions, the model answers and marking scheme are produced in video and printer ready transcripts formats. Also, practice questions for the lecture suite xxx is produced with printer

ready transcript. The set of video and printer ready transcripts for quiz questions, the model answers, marking scheme and practice questions form the quiz suite xxx for lecture suite xxx. The quiz suite is uploaded into the online platform.

b) Generate and assign random number Q (for question distribution) to the students based on the total number of students on the online platform for the course.

Generate the quiz distribution number (Qnum) based on the total number of students that registered on the online platform for the course. Assign the Qnum to the students and create a table that matches the students' registration number with the Qnum.

c) Prepare automatic e-answer booklet that generates the students name registration number name the random number Q for the student

As the student logs in to the online platform and clicks on the quiz menu, his/her registration number, name and Qnum are extracted and used to prepare the e-answer booklet for the student. The student is not required to fill those fields on the e-answer booklets.

d) Activate Quiz submission link and timer

Time frame for submission of answers are shown on the online platform. The quiz submission button remains active within the specified time frame. At the expiration of the time, the quiz submission button is deactivated.

e) Generate and assign random number M (for marking distribution) to the students based on the total number of students that submitted the solution within the timeframe.

Extract the total number of students that submitted their quiz solutions and use that number to generate the quiz marking distribution number 1 (M1num) and quiz marking distribution number 2 (M2num). Create a table that matches the students' registration number with M1num and M2num.
Assign the answer booklet to each of the students such that, a student gets two scripts belonging to two different students such that none of the two scripts belong to the student the scripts are assigned to. In essence, the condition for assigning the scripts are:

i. Student with registration number, REGNUM1 is assigned two answer booklets to mark, where one of the two answer booklets belongs to a student with registration number, REGNUM2 while the second answer booklet belongs to a student with registration number, REGNUM3 ; where REGNUM1≠ REGNUM2≠ REGNUM3.
ii. The registration numbers REGNUM2 is replaced with the corresponding M1num and REGNUM3 is replaced with the corresponding M2num.
iii. The registration numbers REGNUM1 is not reflected on the script so that the student will know the M1num and M2num scripts he marked.
iv. The table is created which matches students registration number with M1num and M2num

f) Activate marked quiz submission link and timer

Time frame for submission of marked quiz answer booklets are shown on the online platform. The marked quiz answer booklets submission button remains active within the specified time frame. At the expiration of the time, the marked quiz answer booklets submission button is deactivated.
The scripts not submitted are reassigned. Those that did not submit their marked scripts are identified and their scripts are withdrawn from the quiz schedules; they are considered as students that did not participate in the quiz.

g) Student mark and compute the total score per question and record it on the record sheet

The quiz answer booklets is locked and cannot be modified except the mark text boxes for the students to put the scores.
The total score per question is entered on the total score textbox.
When the marked quiz answer booklets are received from all the students, the two scores from M1num and M2num are compared; scripts with score difference greater than 40 % are remarked, otherwise the average score is computed and used as the student's score for the quiz.
Restore the student name, registration number and number Q and removes numbers M1 and M2 from the scripts and then, the scripts are sent to the student.

h) Complaint

Students are expected to check their scripts and make complaints where applicable
The course lecturer attends to the complains raised by the students

3. Conclusion

In this paper, a set of procedural mechanisms which can be implemented with software have been presented for management of lecture delivery and assessment of students for classes with large student-to-staff ratio (StSR). The StSR is a parameter that captures how many students are available for each staff in the class. The larger the number the larger the number of students each staff need to attend to. In that case, marking of quiz and examination scripts for

such classes can take a substantial amount of time of the lecturer. In this paper, the quiz marking management system enables the lecturer to use the students to mark the scripts in such a way that it takes roughly about the time of marking two to four scripts for the lecturer to mark the entire scripts of the students irrespective of their population. Also presented is the video frame numbering mechanism that allows the video frames to be tagged and numbered for easy referencing and tracking. Sample video frame numbering were generated and used to explain the ways the video numbering mechanism can be generated and used. The mechanism presented in this paper are meant to be implemented using a web application with requisite mechanisms embedded in it.

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