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A Cloud-based Automated Authoring System to Support e-Learning in Higher Education Under Low-Speed Internet

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***Abstract*— Institutions all over the world are continuously exploring ways to use ICT in improving teaching and learning effectiveness. In higher education, the teaching methodologies are changing from the classroom-based methodology to the so-called Virtual Learning Environment (VLE). To meet the social demands for internationalized higher education, we propose a new automated authoring system for recording and capturing an on-line presentation in the WebELS system. The proposed system enable generating eLearning contents automatically based on a real-time presentation by synchronizing the presenter video and slide-documents materials, which is very valuable for students who did not grasp specific topics, to repeat important parts of the presentation. Furthermore, for those who were not able to attend the live presentation, they can access to the learning contents created at the server side for later reviewing. The automated system is proposed to work on the cloud-computing environment to ensure reliability and scalability of the system. The design concerns non-IT users, and low-speed Internet users, such as in the developing countries.**

***Keywords*—e-Learning, Higher Education, Automated Authoring, on-line presentation, recording, WebELS**

I. Introduction

The rapid advancement of technology and the informatization of society are very important factors that prepared the way for the changing methodologies of higher education. From the traditional classroom-based methodology to the use of information and communications technologies (ICT). It is a new trend to facilitate the interaction and communication between teacher and student, and also to meet the social demands for a flexible educational system. In higher education, students utilize ICT materials to support their learning and research activities. Based on the characteristics of higher education, internet-based e-learning and on-line meeting systems are strongly required to support distance education and boost up the learning curve of learners [1], [2].

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The traditional classroom-based presentations deliver contents in a one-size-fits-all manner to students [3]. It wastes time of more advanced learners by presenting introductory concepts and often is too fast for slow learners who do not possess the required prerequisite knowledge.

Therefore, recording presentations is becoming an increasingly important part of the e-learning content generation in several academic institutions. It is proved to be the fast and efficient way of creating contents for e-learning [4]. Reviewing a recorded presentation might give a real feeling that can be experienced by all senses, that is users view the presentation materiel, see and hear the presenter talk as if one is actually attending a physical lecture. Furthermore, students can access to these learning contents whenever and wherever they wants. In order to acquire every relevant aspect of the live presentation, three basic streams have to be captured. First and foremost, the teachers verbal narration which accompanies the slides presentation. These two sources are considered being essential streams, whereas the live video should be considered in its importance for distance learning. Furthermore, several users technological requirements are requested, e.g., (1) Convenient and quick to create and edit contents, (2) able to edit in the last saved editing stage, (3) able to use the system without software installation, and (4) support structure based navigation to enable some features such as next, previous slide, play and pause video.

A Web-based e-Learning system known as WebELS is a platform that supports flexibility for higher education. WebELS, a server-client system, provides two modules - (1) Learning module for on-demand self-learning, and (2) Meeting module for real-time distance multimedia meeting. To enhance the capability of WebELS in supporting e-Learning in Higher education, as well as the range of use of the system, we proposed a new automated authoring system concept that generates rich multimedia e-learning contents based on a real-time presentation for later off-line reviewing. The proposed system map and create a link between the two modules of WebELS platform, e.g., meeting module to learning module to be an "All-in-one" platform that supports Higher Education activities and meets the social demands.

Furthermore, this work is based on the Authoring system proposed by Chunwijitra [5], and the e-Meeting system designed by Berena [6,7]. In Chunwijitra system, he developed an authoring system to creates e-Learning contents in an off-line mode based on a recorded video and slides document, and the instructor have to synchronize the materials

in a semi-automatic method using a friendly editing interface. Berena [7] designed and implemented the WebELS Meting online presentation that was used to implement the automated authoring system and record the on-line presentation, and then using the editing and viewing mode of the authoring system implemented by Chunwijitra [5].

The new automated authoring system is proposed on the cloud computing environment to ensure reliability and scalability of the system. Cloud computing is a strategic technology that uses the Internet and central remote servers to maintain data and use application without personal software installation. This strategic system allows more efficient computing by centralizing storage, memory, processing and bandwidth.

In this paper, we propose the concept and the design of a new automated authoring system to generate e-learning contents automatically based on a real-time presentation. The proposed system is partially implemented within the WebELS (Web-based e-Learning System) meeting system [7,8]. The tool is for goal to synchronize automatically the presenter video with the slides presentation while the lecture is on-going. Once the presentation is finished, the instructors still have the possibility to edit their learning content for further enrichments, or just save it to generate the content.

The automated authoring system is optimized to support low-speed Internet, cross-platform and cloud computing to widen the scope of users and break the usage limitation. A simple process and a clear user interface were considered in the design. The system is utilized to support distance learning and higher education among universities, and to meet social demands for internationalized education.

II. Related Work

Several approaches consider the problem of automatic lecture capture at the level of single recordings. In these approaches, every step from recording a lecture to creating a fully web learning content is fully automated. Considerable amount of manual work is still necessary for issues such as reservation of lecture halls and distribution of the content produced [9]. The ProjectorBox system seamlessly records RGB information that is sent to a lecture hall`s projector and detects when one presentation end and when the next begins using a heuristic method [10]. This system does not record video of the presenter or his audio signals. EYA system provides features to record the presenter and audiences who are present in the hall in one-hour interval and stores them on a web server for later delivery [11]. Although this system completely eliminates the manual intervention in creating the lecture, these systems do not store the details about the content except its title. In Singapore, video based platform is still on the implementation stage [12]. They have initiated an on-line community of practice for teachers and designed an on-line platform where teachers can share vivid images and videos of thei teaching practices with other teachers. They used Web 2.0 technology to create the website platform prototype. Their proposed platform is only to share content. It could not synchronize video and slide presentation together. Nael Hirzallah proposed the authoring tool system for on-the-fly creation of the video content from the classroom, and save the output in SMIL format [13]. He developed the slide generation algorithm (SG) used to detect the change of slide by capture image from camera. The drawback of his system are requiring high performance system for saving and capturing algorithm, and bad quality of slide images since it was capture via a camera.

The implementation of e-Learning systems on a cloud-computing has its peculiarities and needs a specific approach. Bo Dong presented an e-Learning ecosystem based on cloud computing infrastructure [14]. The benefits of the system are reliable, flexible, and cost-efficient. The system also has mechanisms to guarantee the teaching and learning activities, and the stability of the learning ecosystem. Result shows that the cloud-computing system can reduce the cost of infrastructure maintenance and risk of hardware failure of e-learning systems.

III. System Concept and Methodology

The main goal of this research is to design and develop a new automated authoring system that can create learning contents automatically with synchronized video stream and slide presentation. Thus, the WebELS system modules [15] were used to achieve the proposed approach, since it supports on-line presentations combining video-conferencing and a slides-based document presentation, and an off-line mode to create learning contents to be an “all-in-one” system.

A. *WebELS Overview*

A Web-based e-Learning system known as WebELS is a platform that supports flexibility for higher education [16]. WebELS, a server-client system, provides two modules - (1) Learning module for on-demand self-learning, and (2) Meeting module for real-time distance multimedia meeting. WebELS Meeting supports Synchronous e-Learning approach. The system provides necessary tools for administrating users and online meetings. Furthermore, the system provides easy content authoring, online slide presentation, online annotation, chat messaging and video conferencing. These features effectively demonstrate the usefulness with higher performance of the system in supporting collaborative learning for higher education [15].

Second module is the WebELS Learning system that was designed to support flexibility and globalization of higher education in science and technology in asynchronous mode. Lecturers can use the system to create and maintain contents to be distributed online. The system offers tools like content authoring, content management, user management, course management, on-demand viewer and offline viewer to support lecturers and viewers in the e-Learning process [5].

To enhance the capability of the WebELS platform in supporting e-Learning activities in Higher education, as well as the range of use of the system. We proposed a new

automated authoring system that generates rich multimedia e-learning contents based on a real-time presentation for later off-line reviewing. The proposed system map and create a link between the two modules of the WebELS platform, to be an "All-in-one" platform that supports Higher Education activities and meets the social demands.

B. Video and Slide Presentation Synchronization

Fig. 1 shows the principal technique to synchronize a presentation slides and the video stream. In this method a virtual video clips package is utilized for synchronization. The technical principal behind the automated authoring system is recording the presenter video stream that is used as a baseline of a learning content and the presentation slides are automatically changed by video timing. To synchronize the slides with the video stream recorded, changing the slide image is used as a trigger value to start and stop the synchronization process with the video recorded.

While the presenter is giving the on-line presentation, the automated authoring system is processing in the back-end by recording his/her video stream. Whereas the presenter change the presentation slides using buttons controls such as next, previous, the system set a video time to each slide. In each slide, description section of a meta-data file, start and stop of the video stream position are marked and linked to the slide number of the presentation. Therefore, the video recorded of the presenter will be a series of video clips that will be generated as a virtual video stream out of video clip timing to produce the video content of the learning course.

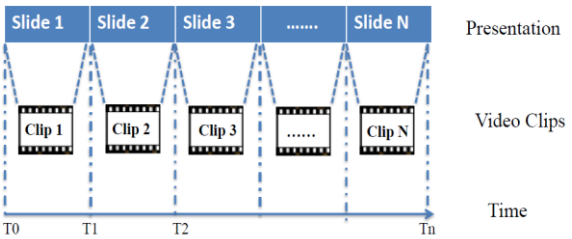

Figure 1. Video and presentation synchronization principal

C. Content Data Structure

In the automated authoring system, a series of slides image or FLV video embedded [17] contents, are used instead of the original presentation file. Fig. 2 shows the data resource of the synchronization process that was designed by Berena, and partially implemented by the first auther. For each slide, a resource data attached to it such as the video clip, image of the slide, and the annotation data that will be developed in the next version of the automated authoring system.

Furthermore, each learning content include some general information i.e., content title, category/subcategory, abstract, author, reference, and description of each slide. Thus, to facilitate searching and referring to the learning contents saved at the server that will be reviewed by the students. To store these contents details, XML document is used. It is considered the best method for changing the meta-data file during editing and reviewing operations.

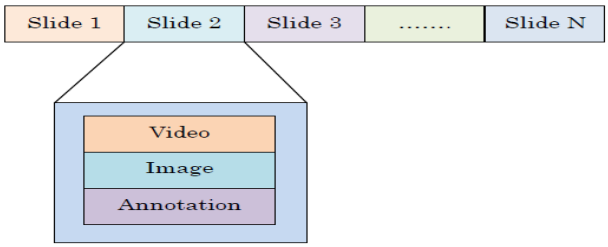

Figure 2. Resource data synchronization.

IV. System Design and Implementation

A. Required Technologies

As technology, we decided to use Flash technology and Red5 media server for implementing the new automated system. For the user interface, Adobe Flash technology [18] is the proper choice since the Flash is the common and most technology used at the moment. It has strong benefits, such as lightweight application, supports cross-platform and can be plug-in to any web browsers. Those are some of the reasons why the WebELS Meeting system was designed using Flash technology [8], and eventually the automated system that is developed within it.

We decided to use Red5 [19] for managing the video stream data of end-users attending the on-line presentation, and to record the presenter video stream. Red5 is compatible with Java technology that is used at the back-end processing of the automated authoring system. Red5 is an open source Media Server that supports the Flash streaming contents. It support RTMP (Real Time Messaging Protocol) for communicating to Flash clients [20], which allows them to dynamically interact with the server to stream and share their audio/video data.

B. System Diagram and Components

Fig. 3 shows the system diagram of the cloud-based automated authoring system designed by Berena and partially implemented by the first author. The diagram demonstrates that the system is based on client server architecture, and the main components of it i.e., recording function and playback function. Since WebELS meeting is a client server architecture, all the events in the meeting system that include the whiteboard for on-line presentation and on-line annotation, video conferencing, chat messaging are in real-time streaming using flash technology on the client side, supported by using

the Red5 as streaming sever. Thus, the automated system will process at the server back-end without influencing the on-line lecture events. Once the presenter click on the recording button, the fully automation system is activated. The system will detect the presenter stream and start recording it, and start synchronizing it with the video as mentioned in section II.B.

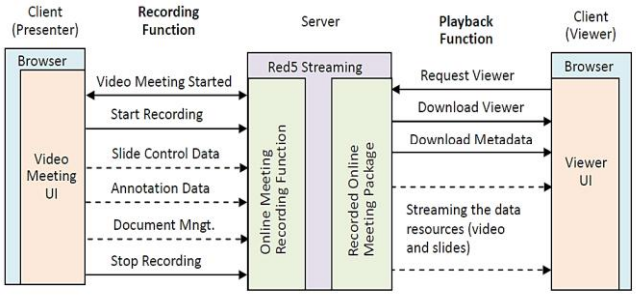

Figure 3. Automated authoring system diagram.

The system process can be resumed as follows: Capture/ Archive/ Process/ Export/ Import/ Edit/ Save. The two main components of the system can describe the previous process operations.

1). **Recording and Authoring Function:**

The WebELS (Web-Based e-Learning System) platform is designed to support higher education activities under low-speed internet environments [16]. Composed of two main modules, Meeting to support on-line presentations and distance discussion. Learning module to enable editors to creates learning contents by uploading their video files and slides document to synchronize them in a semi-automatic way. The goal from developing the automated authoring system is to map between the two modules of the WebELS platform as shown in Fig 4. So, the system will be able to cover and support the most characteristics and activities in post-graduate studies and to meet the social demands for internationalized higher education.

In the WebELS Meeting system, each on-line presentation takes in place a virtual room at the server side. Where, the participants convene via the Internet in the same place, the same time, discussing the same content.

In case the presenter prefers to record his/her presentation, for those who could not attend it on-line. A simple operation is needed from the presenter; by clicking the record button the automated system is activated. The system will detect the presenter stream among the on-line users and start capturing it. Note that only the presenter can record his/her presentation - based on the Meeting policy that allows only the presenter to control the slides changes and to keep contents privacy and protect lecturer's copyrights.

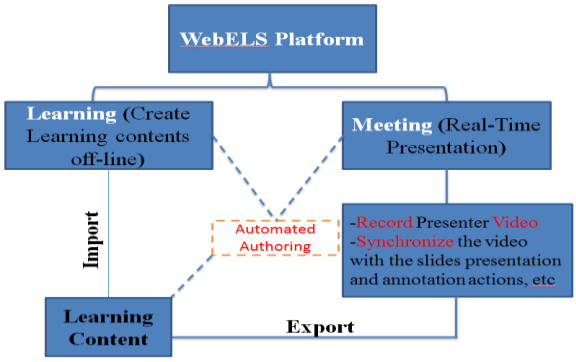

Figure 4. Automated Authoring to map between two modules of WebELS platform.

Therefore, once the Lecturer click on the presenter button, the system will enable the recording button and allow the slides control. In each virtual room, a new lecture folder will be created that contain the recorded presentation data such as: image files, video recorded and the meta-data files to be archived. Whereas the presenter is giving the lecture and recording function is trigged, the system will process at the back-end and create two XML files at the lecture folder.

First, is the metadata file that is used to retain the content definition, such as content title, description, references, etc. The benefit of using metadata file is that it is a simple text file. It is small and fast to transfer between client and server. Second, a content template that is used to keep the synchronization data created during the on-line presentation. Several data are contained in the content template, such as video index, slide index, start and stop values of the video recorded that is attached to each slide. These two XML files will be used for playing back the learning content created, by transferring the data between client and server as shown in the system diagram Fig3.

To make the system robust under the low-speed environments, the system generate the learning content data i.e., slides, video recorded, based on the presenter internet environment. Before the presenter starts the on-line presentation, he/she need to upload the presentation file to the server to be converted to a series of images files or FLV files. During the uploading process, the system proposes three type of images output for conversion that support different bandwidth speed. PNG (low quality image, for internet speed of 100Kbps and below), JPG (Medium quality image, for internet speed between 100Kbps and 1Mbps) and SVG (High quality vector graphics, for internet speed of 1Mbps and higher) [8]. However, so far these images formats are used to support the on-line presentation under low-speed internet and it's not supported in the learning packages automation yet. For the automated authoring system, we selected PNG quality as a standard for the learning courses, and it is planned to include other formats such as SVG, FLV etc in the next version of the system.

The video in e-Learning can be a powerful way for any organization to meet its learning objectives effectively and rapidly. However, one of the biggest considerations for using video in e-Learning courses is managing the file size.

Therefore, we considered both the size of the video recorded and the quality during the automation process. To support both the presenter video streaming during the on-line presentation, and the streaming recording we developed the automatic streaming adaptation [21]. Thus, the system will calculate the presenter bandwidth every 10 seconds during recording the real-time presentation. The quality of the video output will then depends on the presenter Internet speed. After testing the video streaming recording under different bandwidth environment, we did set-up the quality decision of the streaming that differ depends on the presenter bandwidth value calculated by the system. Table 1. Shows that if the bandwidth value (BW) <50Kbps the user can only record the audio voice without camera to decrease the traffic, if 50<BW<100Kbps the system will record low quality of streaming for the presenter, if 100<BW< 200Kbps the system will record a normal quality of video and voice, and if the user bandwidth is more than 200Kbps, the system will record a high quality of video/audio streaming. Moreover, the presenter can select one of these qualities of streaming manually instead of automatic, by mean select whether audio only, low, medium, or high quality prefer to use.

TABLE I. Conditions for quality decision.

Average Bandwidth	Audio/Video Quality
<50 Kbps	Voice Only
50-100 Kbps	Low Quality
100-200 Kbps	Medium Quality
>200 Kbps	High Quality

Once the presentation is finished, the presenter need only to click on the stop recording button to terminate the automation process. At the back-end, the system will generate the learning content package in a few seconds which is the output container of the learning content. It includes metadata, presentation slides, video stream, and synchronization data. Hence, the presenter can export this package, and import it to the WebELS Learning module of the WebELS platform [15]. Export function will compress the learning content package to a ZIP file to be downloaded at the presenter machine. This ZIP file will be imported to the WebELS Learning module. Moreover, once the learning content package is imported to the learning module, the presenter can still edit the content. Based on the editing mode implemented by Chunwijitra [5], Editing Control Panel contains synchronization tools, remove synchronized video, add blank slide, remove slide, pointer movement management and slide information editor. Slide and video synchronization is easily done in this authoring interface. Content editing is possible without any third-party software. Moreover, the cursor movements as well as the presenter handwriting annotation recording, is planned to be developed in the next version of the automated authoring system, to be fully automatic and facilitate the creation of a rich multimedia learning contents.

2). **Playback Function:**

After the above process is successfully finished and the learning content is imported to the learning module, the playback function is called. The learner who could not attend the on-line presentation, can access to the learning contents saved at the WebELS Learning server. The learner mode is used for the playback function and to display the learning content. It was designed and implemented by Chunwijitra [5], in a friendly and easy to use user interface, to break-down the need of IT skills. When the student selects the recorded learning content created in the on-line presentation to review it. The meta-data of that content is automatically downloaded by the player and automatically starts playing. The student can control the content by play or pause the video of each slide depend on the video clip synchronization. Moreover, several useful functionalities are implemented in the playback panel i.e., video and slide view toggle, video zoom, slide zoom, video and full screen mode. While viewing the learning content, network connection is always needed for on-line flash streaming from the server.

V. Experimental Result and Discussion

In this paper, we presented the concept, methodology, and the partial implementation of the automated authoring system. That is for goal to generate learning contents automatically based on a real-time presentation. Fig. 5, Fig. 6 shows the interface design of both the e-Meeting system that was used to record and the learner mode for playback.

Fig. 5 shows the WebELS Meeting interface, that combines a video conferencing and an electronic whiteboard in same panel. Therefore, all the required data used to record the presentation appear in the same window. The automated authoring system required the three panels shown in Fig. 5, namely (1) audio/video stream data, (2) record button, and (3) the slide index information. The system does not require any IT skills to be used, the interface is clear and easy to understand.

To activate the automated system, the presenter needs to click only on the record button. The system will detect the presenter stream among the end-users and start recording it. While the presenter is giving his/her presentation by controlling the slides change i.e., next, previous, last slide, first slide the system is dividing the presenter video stream recorded to a short video clips. These video clips will be automatically linked to each slide, and send it to the content template file to save the synchronization process.

Based on the video and slide presentation synchronization techniques, the proposed system is more convenient for creating the learning content. The system allows the presenter to make the on-line presentation, and save time to create the same content for students who could not attend in the real-time. Furthermore, the system allows presenters to re-edit the

learning content once it's imported to the WebELS Learning module.

Fig. 6 shows the user interface of the learner mode that will be used to playback the learning content saved at the server side [5]. It consists of four panels which are (1) Video panel for displaying the video clips recorded of the current slide, (2) Slide panel for displaying the current slide, (3) Content Information panel for the slides details (number, title, and description), (4) Control panel for managing the online learning content. Learners can toggle view between video and slide views. They also can zoom both video and slide contents. Moreover, full screen mode is supported to be suitable to display the content through a projector in case of classroom.

The metadata file containing learning content information such as: title, abstract, author, reference, etc., allow learners to easy find the specific content to view. Furthermore, the playback function allows the advanced students who need to see and repeat only the problematic part of the presentation. In the part (3) of the learner mode interface Fig. 6, students can select any slide to view based on its title. Each slide can be viewed as long as needed by students.

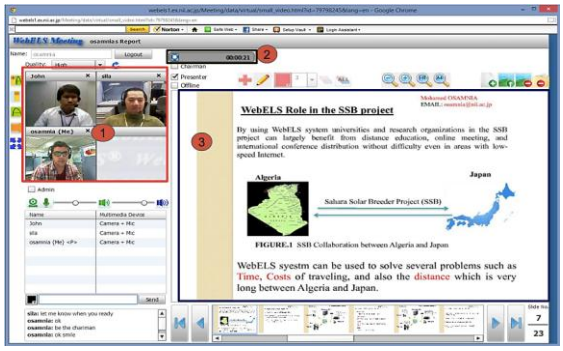

Figure 5. e-Meeting interface used for start recording

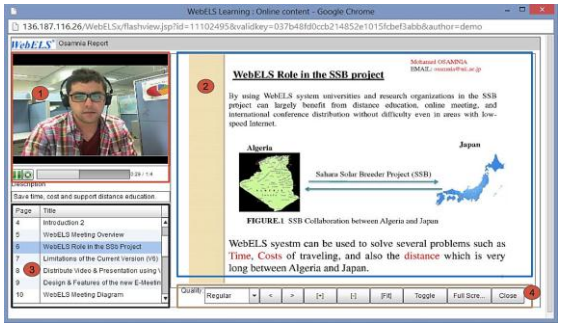

Figure 6. Learning mode interface for playback.

One other key offered in the proposed system is the authoring operation to generate the learning contents. Often, to generate the learning content, Professors have to use some authoring tool systems, where they have to prepare a recorded video, and the slide presentation. Moreover, these data should be uploaded to the server to be converted, what generally take long time for both the uploading and the conversion process. Furthermore, another process comes next which is the semi-automatic synchronization in order to create the learning content. The semi-automatic synchronization requires the Professors to listen to the entire lecture and wait for the right timing to do the synchronization with the proper slide as proposed in Chunwijitra authoring system [5]. These operations take time and sometimes complicated for non-IT skills Professors, and moreover those contents could not be discussed on-line. To enable both the real-time presentation and generate a learning content for Professors, our system was proposed. The content automation system breakdown the need for IT skills, and enable students who could not attend the on-line discussion to still review it in off-line mode. The synchronization is fully automatic and each virtual video is linked to the proper slide as mentioned in section 3.2. Once presentation is finished, the presenter can download their learning content package from the Meeting server, and import it to the Learning module of the WebELS platform to be saved for later reviewing. Since the data captured size is small, even in low-speed internet the export/import process will take a short time depending on the video recorded length.

VI. Conclusion

In this paper, we presented the concept, design and the partial implementation of a proposed new automated authoring system. This system targets lecturers and students in the higher education, for the flexibility and globalization of post-graduate studies. The system will generates learning contents automatically based on a real-time presentation, synchronizing the lecturer video stream and the slides presentation by means of video clip timing. It composes of two main functions, recording function and playback function. When the recording function is trigged during the on-line presentation, at the back-end the automated system start processing to record the presentation and create the learning content. The playback function is used to review the content stored at the server side by learners, who could not attend the real-time presentation or for further understanding of the lecture. Both recording and playback function were designed for non-IT users by simple to use interface and to be stable under low-speed internet. Furthermore, the automated authoring system was proposed to work on the cloud-computing environment to ensure reliability and scalability of the system. A future work, we will finish the implementation of the automated authoring system. Moreover, new features will be included to the proposed system such as, handwriting capturing, cursor movement, etc. The system will be used and evaluated based on practical experiments to enhance the quality and the output of the learning content courses.

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