PERFORMANCE EVALUATION OF CONCEPTUAL MODEL INSTANCE (CMI) DATA FOR E-LEARNING MULTIMEDIA PRESENTATIONS IN SCORM RUN-TIME ENVIRONMENT

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ABSTRACT

The paper aims to describe dynamic presentation generator that presents the same content in different ways through different media object and presentation layouts. The different media presentation will then display to student via Learning Management Systems (LMS). The paper also presents SCORM Compliant Learning Objects and Conceptual Model Instance (CMI). The prototype is then evaluated to demonstrate the performance of the students where the CMI data are collected for each student. The data collected include media preference, test score and time spent to study the Computer Programming subjects. The results show that with more media object used, students spent more time on the Webpages. However, the results also showed that using more media object may not produce better results in the assessment.

Keywords: E-learning, LMS, SCORM

The e-Learning market has grown rapidly in the last few years and the trend will continue (Gerhard, et al., 2002). However, most of the current e-Learning layouts or presentations are static and inflexible (Ahmad, 2004). The learning environment does not adapt to the students preferred learning strategies (Kolb, 1986). The same presentation is viewed by all students without considering their preferences and abilities (Sonwakler, 2002). Learners come from diverse backgrounds; they have different learning preferences, different levels of interest and different learning styles. It is important to overcome the one-size-fits-all approach and provide learners with individual learning experiences (Frasincar et al., 2004). Thus, the dynamic generation of multimedia presentations is essential for any advanced distance learning system. The dynamic presentation generator is able to provide high-quality instruction anytime, anywhere, tailored to each learner's needs. It is aimed at catering multimedia information to the information needs of different learners by adapting the media and layout of presentation to each individual learner. In the research, the dynamic presentation generator was developed to integrate with SCORM-compliant LMS to demonstrate the performance of the students. The effectiveness of media objects multimedia presentation is evaluated with the collection of CMI data.

DYNAMIC PRESENTATION GENERATOR AND LEARNING MANAGEMENT SYSTEM

Dynamic Presentation Generator (PG) creates the multimedia presentations for students based on personalisation parameters from the SCORM player. The core of the PG is a piece

of software called an XML parser. It is a component that reads an XML file and converts to another form for display in a Web browser. Microsoft's XML parser is a COM component that supports all the necessary functions to traverse the node tree, access the nodes and their attribute values, insert, delete nodes and convert the node tree back to XML.

A Learning Management System (LMS) simplifies the process of administering education and training (Apostolopoulos et al., 2003). It is a complex system used by managers, administrators, instructors, and learners to schedule, register, bill, and track learner through courses and other learning events. It lets learners find and register progress through a course or program of learning. Finally, it helps administrators manage training programs and compile statistics and reports. LMSs help create and offer courses and curricula. Their primary function is to offer a collection of courses. They may also include capabilities for assembling individual courses into organized curricula or certificate programs (Lewis et al., 1998). At the course level, LMSs provide an ability to launch and track performance within courses.

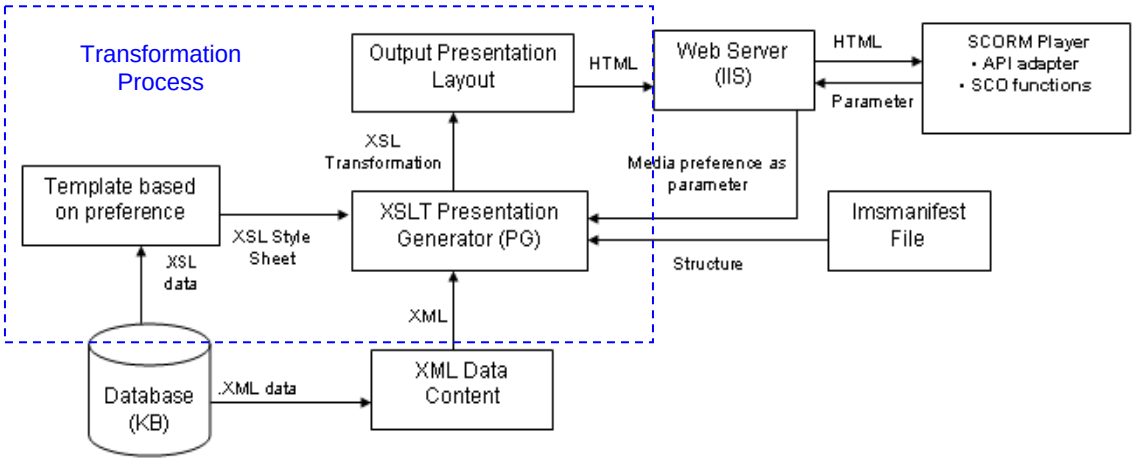

Figure 1. Architecture of the proposed prototype system

Figure 1 shows the proposed prototype system. XSLT Presentation Generator is the mian body of Dynamic Presentation Generator whereas SCORM Player is the main body of LMS. The LMS will send the media preference parameter to PG. PG retrieves the appropriate XSL template from database. From the input of *imsmanifest* file as structure, PG will retrieve the XML data content from database. The transformation process will be performed and the output presentation will be sent to SCORM player through IIS Web server.

It is important in e-Learning arena as it creates layout presentation dynamically based on user's selection. This is important in order to ensure the flexibility of learning content and system. Besides, PG is developed to overcome one-size-fits-all approach by generating several different multimedia presentations from single source of content.

Sharable Content Object Reference Model (SCORM)

A number of organizations have been working on different but closely related aspects of Web-based learning technology. While these evolving areas have recently made great strides, they

have not been well "connected" to one another. Some emerging specifications are quite general; in others the specifications are rooted in earlier Conceptual Model Instance (CMI) practices and require adaptation to Web-based applications (Advanced Distributed Learning Org, 2001). First released in January 2000, SCORM continues to update the scope of the specifications through cooperation with industry, government and academic participants.

SCORM is one of the most significant and widely used specifications for learning content packaging. The SCORM Content Model describes the SCORM components used to build a learning experience from learning resources. The content model also defines how these lower level sharable, learning resources are aggregated into higher-level units of instruction. The SCORM Content Aggregation Model (ADL, 2004) contains the following components: Assets, Sharable Content Object (SCO) and Content Aggregations. Assets are an electronic representation of media objects, text, images, audio, Web pages or other data that can be presented in a Web client. A SCO represents a collection of one or more assets. To improve the reusability, a SCO should be independent of its learning context. A SCO can be reused in different learning experiences to fulfil different learning objectives. SCOs are meant to be small units, such that reusability in more learning objectives is feasible. A Content Aggregation is a map (content structure) that can be used to aggregate learning resources in a well integrated unit of education (for example course, chapter, lesson, and topic).

SCORM Compliant Learning Objects

SCORM Compliant Learning Objects are learning objects that are able to communicate with a Learning Management System to record user scores, times and progress (ADL, 2002). These are the most portable and reusable of learning objects as they will work with any SCORM compliant Learning Management System. To ensure that the objects themselves are even more portable, SCORM recommends that several other rules be followed when developing the learning objects. Each learning object is a standalone entity. It does not rely on other learning objects to function, and does not specifically refer to other learning objects.

SCORM defines a Web-based learning Content Aggregation Model (CAM) and RTE for learning objects (SCORM, 2004). RTE describes runtime API and data model used for communication between content object and LMS. In SCORM, the actual LMS API calls are included in a SCO when it is created in its final output format. A SCO is an entity that is able to communicate with the LMS using some special (JavaScript, ECMAscript) functions.

API adapter is implemented to enable SCO page to communicate with LMS. Besides, it is implemented to validate data being exchanged via define Conceptual Model Instance (CMI). In addition, it is used to perform API SCO function. A SCORM conformant LMS is required to implement eight functions on API.

The API is implemented on API adapter that resides in a window, either opener window or parent frame of the window. LMS may launch the content either in a new window or in a frameset. Figure 2 illustrates the communication between API adapter and SCORM content browser.

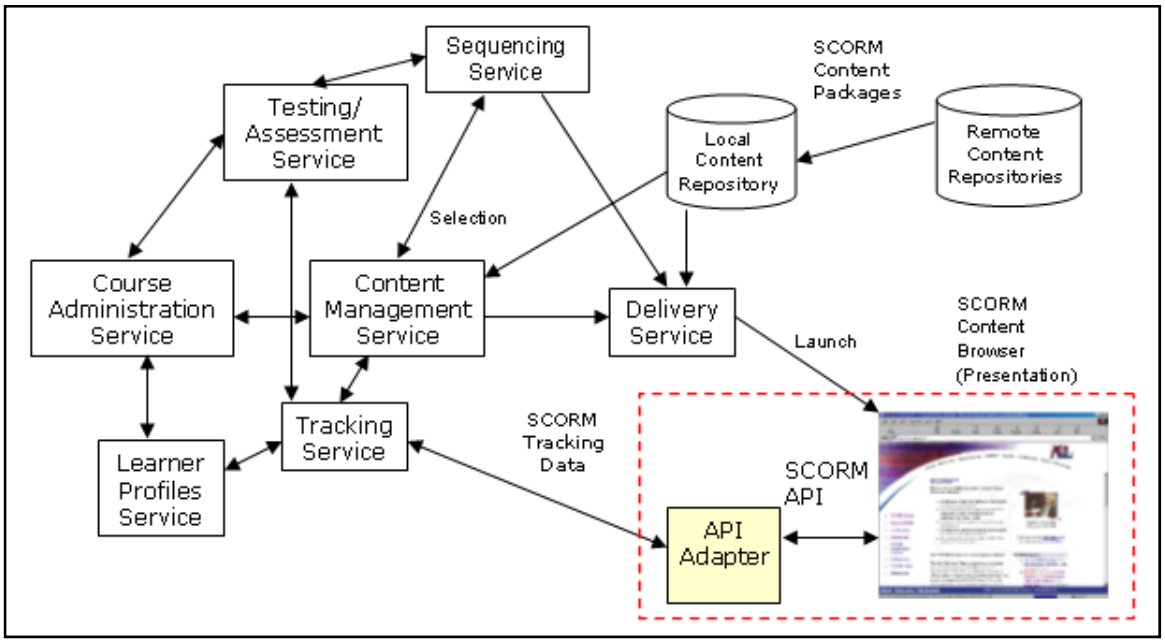

Figure 2. SCORM API (ADL, 2002)

PERFORMANCE EVALUATION VIA SCORM-COMPLIANT PROTOTYPE SYSTEM

The performance evaluation involves the capturing process for time spent, media selection and score mark data. The time spent, media selection and score mark data were captured and sent to the server, which then saved the data into the database. The SCOs lessons for Computer Programming consist of three lessons, three assessments and one final exam respectively.

Media Preference

There are five types of media objects: text, graphics, animation, video and audio used to study Computer Programming subject. Table 1 illustrates the data of top four media selection. The top four media preferences (91 out of 140 respondents, 65%) are used to obtain the findings.

Table 1. Top Four Media Preferences with Number of Students

Media Preference	Number of students	Percentage (%)
Text + Graphics	17	12
Text + Animation	20	14
Text + Graphics + Audio	25	18
Text + Graphics + Animation + Video	29	21
TOTAL	91	65

Time Spent

The individual time spent data of each student for each SCO page was collected during prototype evaluation. It is categorized based on media preferences.

Table 2 shows the breakdown of pages for three lessons in Computer Programming. As observed from Table 2, lesson 1 consists of 6 pages, lesson 2 consists of 7 pages, lesson 3 consists of 5 pages and 1 page for final exam.

Table 2. Number of Pages for 3 Lessons in Computer Programming

Lesson	Page							No. of Pages
Lesson 1	Intro	SCO1	SCO2	SCO3	SCO4	Ass1		6
Lesson 2	Intro	SCO1	SCO2	SCO3	SCO4	SCO5	Ass2	7
Lesson 3	Intro	SCO1	SCO2	SCO3	Ass3			5
Final Exam	SCO1							1
TOTAL								19

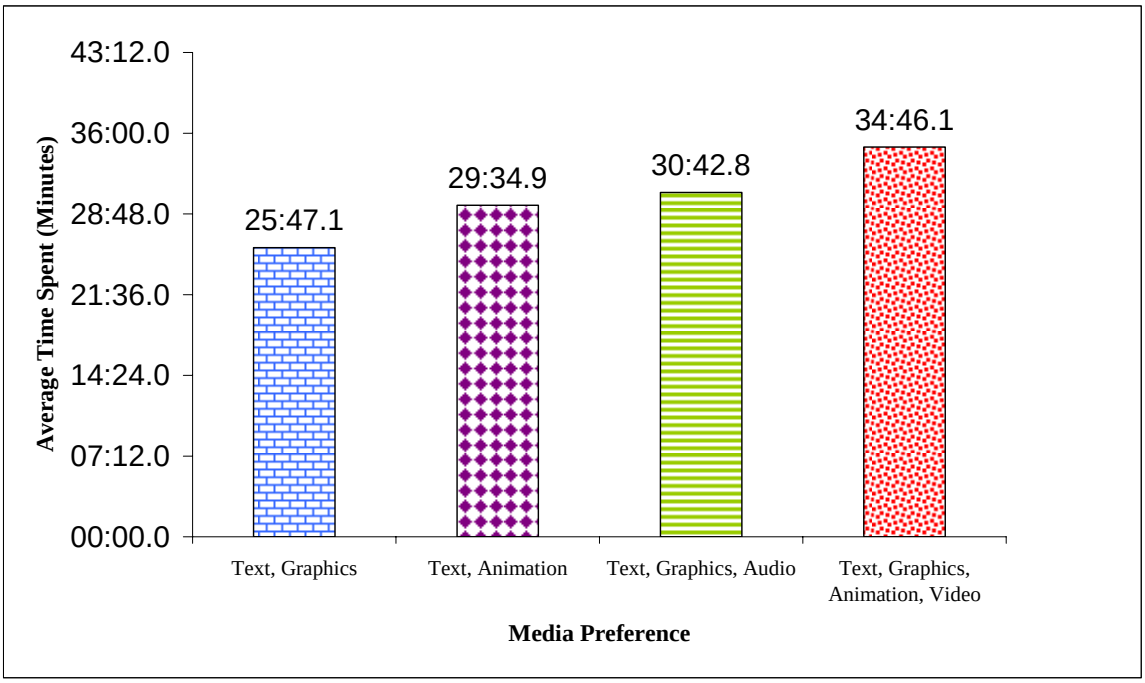

Figure 3. Average time spent for students with the top four media preferences

Figure 3 shows the average time spent in minutes with the selected media preference for students during prototype evaluation to study Computer Programming subject. As observed from Figure 3, students who chose the combination of *text, graphics, animation and video* media preference spent the longest average time spent while students who chose the *text and graphics* media preference spent the shortest average time spent. The average time spent increases when there are more media in the media preference.

Test Results

There are three assessments and one final exam. The three assessments are assessment 1 (in lesson one), assessment 2 (in lesson two) and assessment 3 (in lesson three). Each assessment consists of five questions and each question carries 20% of the marks. The individual data from each student for each assessment was collected during prototype

evaluation. The data are categorized based on top four media preferences. The top four media preferences are *text and graphics*, *text and animation*, *text, graphics and audio, text, graphics, animation and video*.

Table 3 illustrates the average score for 3 assessments and 1 final exam based on top four media preferences. Students who chose *text and animation* media combination achieved highest average score for each assessment.

Table 3. Average Score of Each Assessment for Top Four Media Preferences

Media Preference	Average Score (Assessment 1)	Average Score (Assessment 2)	Average Score (Assessment 3)	Average Score (Final)
Text + Graphics	67.06	57.65	54.12	69.41
Text + Animation	77	84	83	76
Text + Graphics + Audio	72	74.4	81.6	72
Text + Graphics + Animation + Video	71.03	66.21	66.21	64.83

Table 4 illustrates the breakdown of students who score full marks as average scores. Out of 17 students, the biggest numbers of students (7) who score 100% are from *text, animation and video* media preference (28% of respondents who choose the media preference).

Table 4. Percentage of Students Who Score Full Marks for Top Four Media Preferences

Media Preference	No. of Students Who Score 100% as Average Score	Total No. of Students	Percentage (%)
Text + Graphics	3	17	18
Text + Animation	4	20	20
Text + Graphics + Audio	7	25	28
Text + Graphics + Animation + Video	3	29	10

Table 5 illustrates the average score (AS) achieved by each student based on the media preferences. The table shows the average score for each media preference.

Table 5. Average Score for Each Student and Average Score for Each Media Preference

Media Preference	Text, Graphics		Text, Animation		Text, Graphics, Audio		Text, Graphics, Animation, Video	
	SID	AS	SID	AS	SID	AS	SID	AS
	1	45	1	70	1	80	1	80
	2	75	2	95	2	70	2	70
	3	70	3	100	3	100	3	80
	4	35	4	100	4	60	4	70
	5	45	5	60	5	75	5	85
	6	100	6	60	6	55	6	55
	7	50	7	65	7	100	7	65
	8	55	8	100	8	60	8	100
	9	100	9	90	9	65	9	65
	10	40	10	70	10	100	10	70

Table 5. (continued)

Media Preference	Text, Graphics		Text, Animation		Text, Graphics, Audio		Text, Graphics, Animation, Video	
	SID	AS	SID	AS	SID	AS	SID	AS
	11	50	11	80	11	70	11	65
	12	55	12	85	12	100	12	75
	13	100	13	65	13	75	13	50
	14	60	14	100	14	55	14	65
	15	45	15	70	15	75	15	70
	16	60	16	75	16	50	16	70
	17	70	17	80	17	100	17	45
			18	80	18	50	18	55
			19	80	19	100	19	100
			20	75	20	60	20	40
					21	75	21	65
					22	65	22	55
					23	100	23	80
					24	70	24	50
					25	65	25	70
							26	100
							27	45
							28	55
							29	50
Average		62.06		80		75		67.07

Table 6 and Figure 4 illustrate average score (%) for each media preference. The highest average is achieved by students who chose *text and animation* media combination while the lowest is achived by students who chose *text and graphics* media combination.

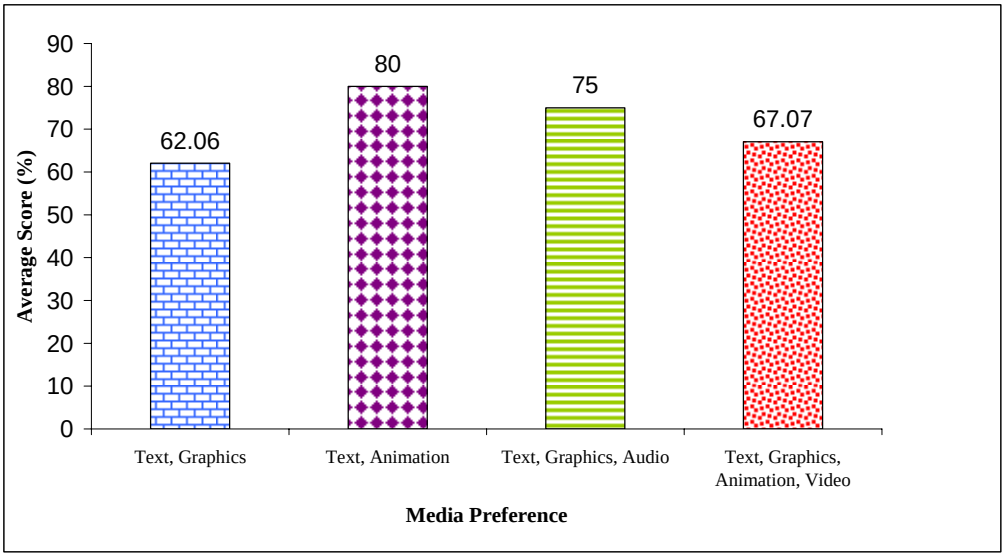

Figure 4. Average score for each media preference

Table 6. Average Score for Each Media Preference

Media Preference	Average Score (%)
Text + Graphics	62.06
Text + Animation	80
Text + Graphics + Audio	75
Text + Graphics + Animation + Video	67.07

Analysis (Test Results versus Time Spent)

Table 7. Average Score and Average Assessment Time of Each Assessment for Each Media Preference

Media Preference	Average Score (Ass1)	Average Ass Time (Ass1)	Average Score (Ass2)	Average Ass Time (Ass2)	Average Score (Ass3)	Average Ass Time (Ass3)	Average Score (Final)	Average Ass Time (Final)
Text, Graphics	67.06	02:22.1	57.65	02:41.4	54.12	02:25.7	69:41	03:22.0
Text, Animation	77	02:23.0	84	02:41.8	83	02:25.9	76	03:26.1
Text, Graphics, Audio	72	02:24.5	74.4	02:44.4	81.6	02:25.7	72	03:26.5
Text, Graphics, Animation, Video	71.03	02:23.1	66.21	02:42.3	66.21	02:26.0	64.83	03:24.5

Table 7 shows the average score and average assessment time of each assessment for the top four media preference. The highest average score for each assessment is achieved by students who chose *text and animation* media preference. The assessment time for all four types of media preference is almost the same. Student spent more time in final exam compared to the other three assessments.

Table 8. Shortest Time Spent of Student Who Scores 100%

Media Preference	Shortest Assessment Time (minutes)
Text + Graphics	25:26.8
Text + Animation	29:18.4
Text + Graphics + Audio	30:37.3
Text + Graphics + Animation + Video	35:13.0

Table 8 illustrates the shortest time to study three lessons (3 introduction page, 12 SCO pages, 3 assessments and 1 final exam) for student who achieved 100% based on the top four media preferences.

Table 9. Summary of Average Score and Average Time for Assessment 1, 2, 3 and Final Exam for Top Four Media Preferences

Media Preference	SA1	TA1	SA2	TA2	SA3	TA3	SFE	TFE
Text, Graphics	67.06	02:22.1	57.65	02:41.4	54.12	02:25.7	69.41	03:22.0
Text, Animation	77	02:23.0	84	02:41.8	83	02:25.9	76	03:26.1
Text, Graphics, Audio	72	02:24.5	74.4	02:44.4	81.6	02:25.7	72	03:26.5
Text, Graphics, Animation, Video	71.03	02:23.1	66.21	02:42.3	66.21	02:26.0	64.83	03:24.5

Table 10. Indication of SA1, TA1, SA2, TA2, SA3, TA3, SFE and TFE

Indication	Description
SA1	average score of assessment 1
TA1	average time of assessment 1
SA2	average score of assessment 2
TA2	average time of assessment 2
SA3	average score of assessment 3
TA3	average time of assessment 3
SFE	average score of final exam
TFE	average time of final exam

Table 9 illustrates the average score and time spent for assessment 1, 2, 3 and final exam. Table 10 shows the meaning of SA1, TA1, SA2, TA2, SA3, TA3, SFE and TFE symbol in Table 9.

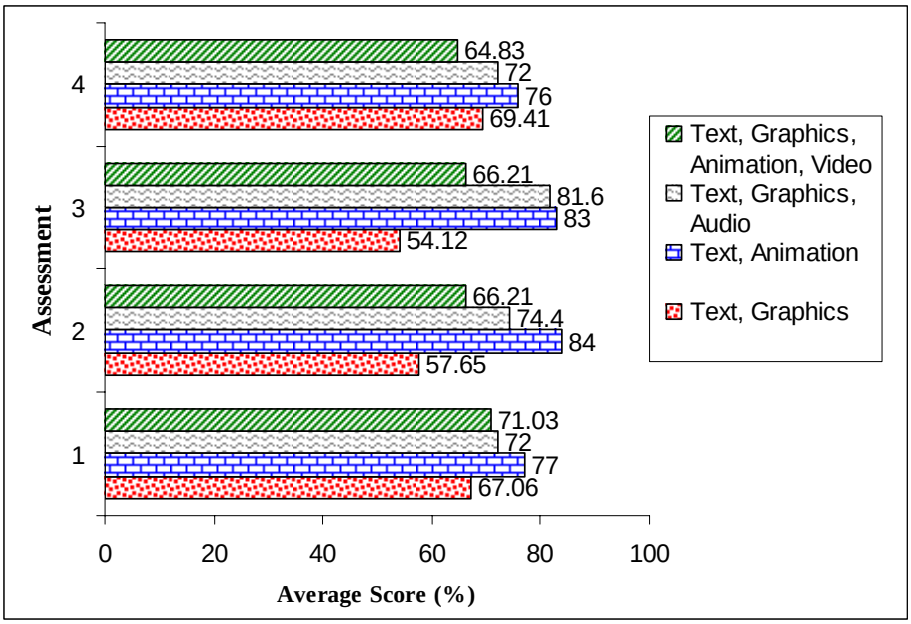

Figure 5. Average score of each test for top four media preferences

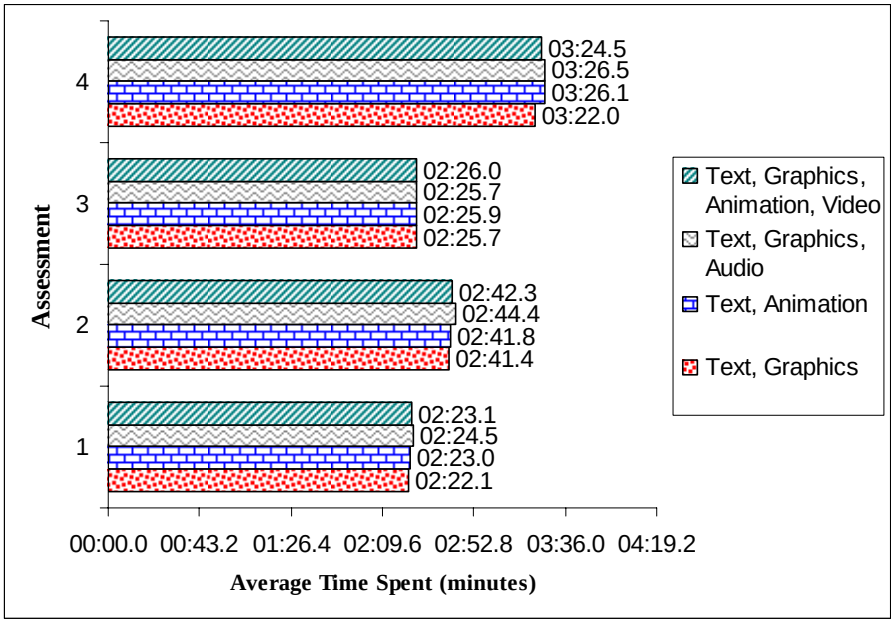

Figure 6. Average time spent of each test for top four media preferences

Figure 5 shows the average score of each test: 1 (assessment 1), 2 (assessment 2), 3 (assessment 3) and 4 (final exam) for top four media preferences. Figure 6 illustrates the average time for each test as mentioned above for top four media preferences. Both figures are based on Table 9.

Table 11 shows average time spent and average score achieved for Computer Programming subject based on media preferences. The table shows that students who chose the combination of *text and graphics* media preference spent the shortest average time to study the three lessons but achieved the lowest average score. The highest average score are achieved by students who chose the combination of *text and animation* media preference. The average time spent to study three lessons is around 29 minutes. The results show that combination of *text, graphics, animation and video* does not contribute as efficiently as *text and animation* in the course.

Table 11. Summary of Average Time Spent and Average Score for the Top Four Media Preferences

Media Preference	Average Score (%)	Average Time Spent (minutes)
Text + Graphics	62.06	25:47.1
Text + Animation	80	29:34.9
Text + Graphics + Audio	75	30:42.8
Text + Graphics + Animation + Video	76.55	35:29.9

CONCLUSION

The paper presents the dynamic presentation generator which has been integrated into SCORM-compliant LMS. The dynamic presentation generator display different media

presentation based on the student's preference via LMS. The peformance of students will then evaluated base on collected data. The data collected include media preference, test score and time spent to study the Computer Programming subject. The results and findings of the prototype evaluation will then studied. *Text, graphics, animation and video* media combination is the most popular media preference among undergraduate students to study Computer Programming subject. Students who choose *text and animation* media combination achieved the best average score. The results show that with more media used, students spent more time on the webpages. However, the results also showed that using more media may not produce better results in the assessment.

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